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(54) **FACILITATING DISCOVERY OF VERBAL COMMANDS USING MULTIMODAL INTERFACES**

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G06F 16/68 (2019.01)
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(52) **U.S. Cl.**
CPC ***G06F 3/167*** (2013.01); ***G06F 3/0481*** (2013.01); ***G06F 3/0482*** (2013.01);
(Continued)

(58) **Field of Classification Search**
CPC G06F 3/167; G06F 3/0484; G06F 2203/0381; G06F 16/686; G06F 16/90324;
(Continued)

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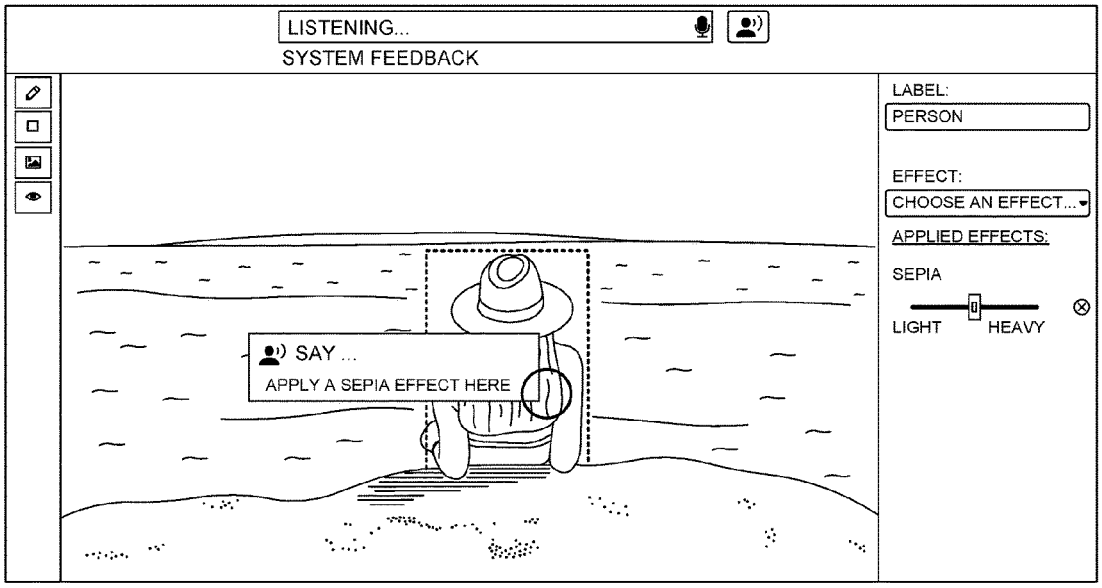
(57) **ABSTRACT**

A framework for generating and presenting verbal command suggestions to facilitate discoverability of commands capable of being understood and support users exploring available commands. A target associated with a direct-manipulation input is received from a user via a multimodal user interface. A set of operations relevant to the target is selected and verbal command suggestions relevant to the selected set of operations and the determined target are generated. At least a portion of the generated verbal command suggestions is provided for presentation in association with the multimodal user interface in one of three interface variants: one that presents command suggestions as a list, one that presents command suggestions using contextual overlay windows, and one that presents command suggestions embedded within the interface. Each of the proposed interface variants facilitates user awareness of verbal commands that are capable of being executed and teaches users how available verbal commands can be invoked.

18 Claims, 16 Drawing Sheets



(51) **Int. Cl.**

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G06F 3/0487	(2013.01)
G06F 9/451	(2018.01)
G06F 3/0481	(2013.01)
G06F 16/9032	(2019.01)
G06F 3/0483	(2013.01)
G10L 15/22	(2006.01)

(52) **U.S. Cl.**

CPC ***G06F 3/0483*** (2013.01); ***G06F 3/0487*** (2013.01); ***G06F 9/451*** (2018.02); ***G06F 9/453*** (2018.02); ***G06F 16/686*** (2019.01); ***G06F 16/90324*** (2019.01); ***G10L 15/22*** (2013.01); *G06F 2203/0381* (2013.01); *G10L 2015/223* (2013.01)

(58) **Field of Classification Search**

CPC G06F 3/0482; G06F 3/0483; G06F 3/0487; G06F 3/0481; G06F 9/451; G06F 9/453; G10L 15/22; G10L 2015/223

See application file for complete search history.

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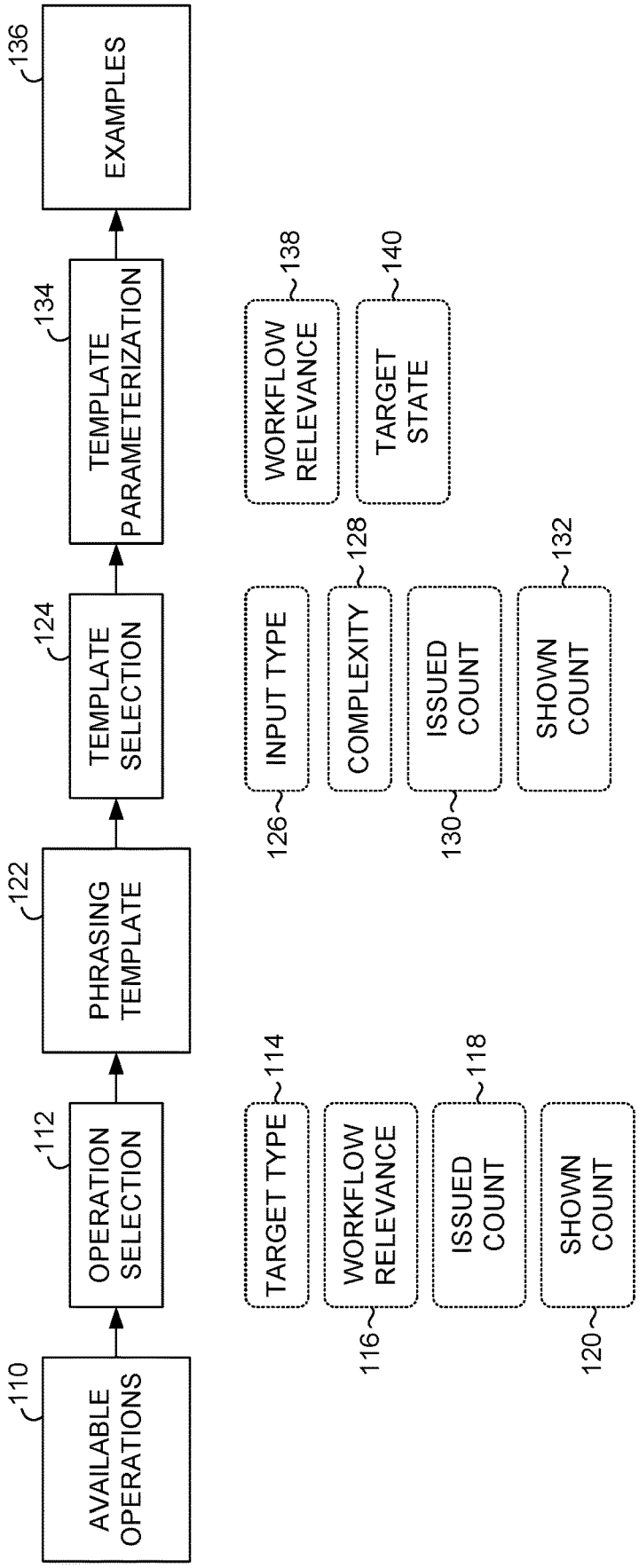
AVAILABLE OPERATIONS
110
OPERATION SELECTION
112
PHRASING TEMPLATE
122
TEMPLATE SELECTION
124
TEMPLATE PARAMETERIZATION
134
EXAMPLES
136
TARGET TYPE
114
WORKFLOW RELEVANCE
116
ISSUED COUNT
118
SHOWN COUNT
120
INPUT TYPE
126
COMPLEXITY
128
ISSUED COUNT
130
SHOWN COUNT
132
WORKFLOW RELEVANCE
138
TARGET STATE
140

FIG. 1.

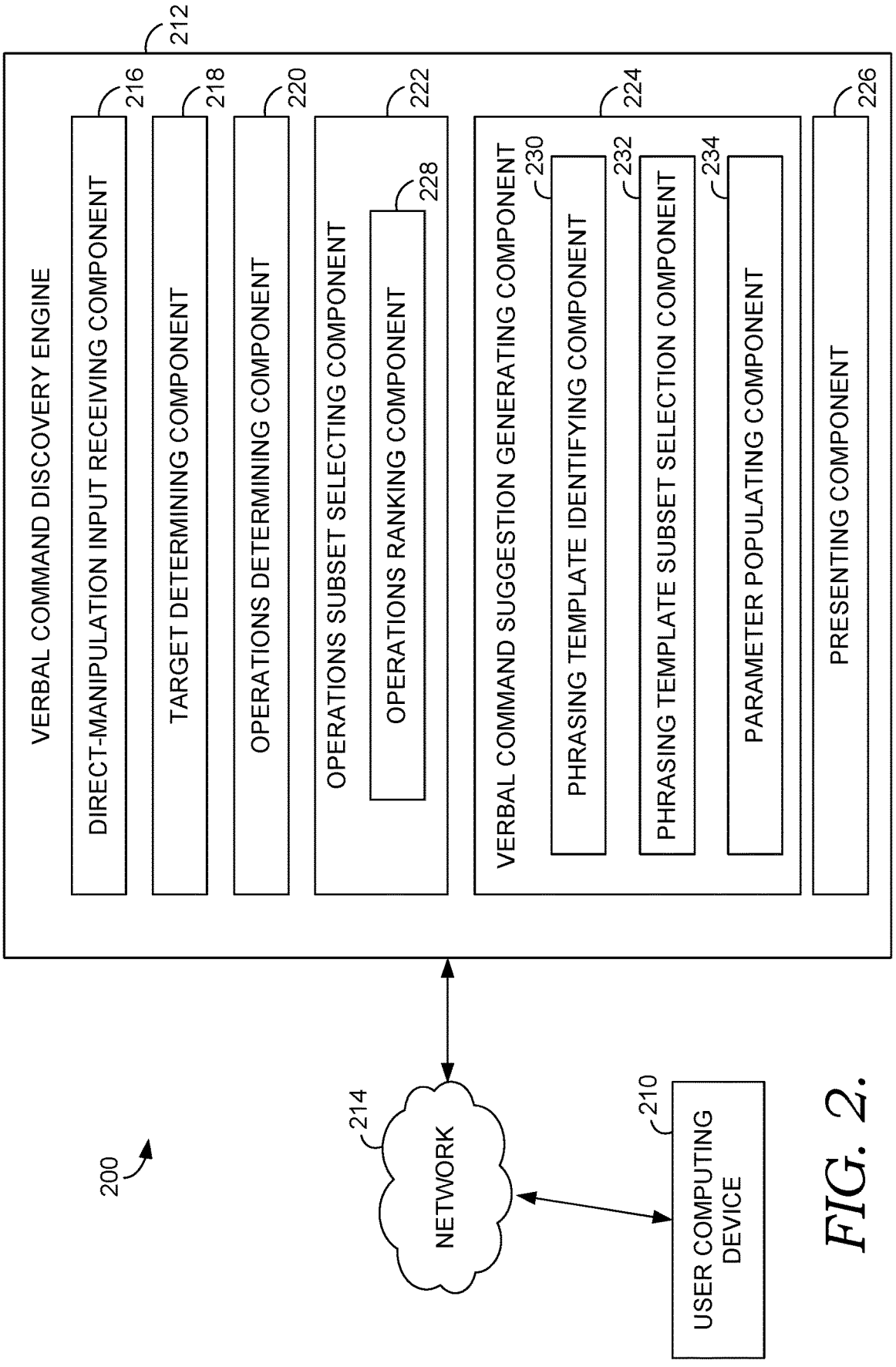
200
212
VERBAL COMMAND DISCOVERY ENGINE
216
DIRECT-MANIPULATION INPUT RECEIVING COMPONENT
218
TARGET DETERMINING COMPONENT
220
OPERATIONS DETERMINING COMPONENT
222
OPERATIONS SUBSET SELECTING COMPONENT
228
OPERATIONS RANKING COMPONENT
224
VERBAL COMMAND SUGGESTION GENERATING COMPONENT
230
PHRASING TEMPLATE IDENTIFYING COMPONENT
232
PHRASING TEMPLATE SUBSET SELECTION COMPONENT
234
PARAMETER POPULATING COMPONENT
226
PRESENTING COMPONENT
214
NETWORK
210
USER COMPUTING DEVICE

FIG. 2.

Operation		Parameters	Applicable to	Phrasing Templates	Examples
Filter	Add Filter	*name, value	Canvas image, Entity, Region, Image tile	Apply a ____ filter on ____ Add a ____ ____ effect to the canvas Add ____ ____effect here Apply ____ filter	Apply a grayscale filter on all cars Add a heavy saturate effect to the canvas Add light morph effect here Apply sepia filter
	Edit Filter	*name, *value	Canvas image, Entity, Region, Image tile	Set the value of the _ filter on _ to _ Change ____ effect on ____ to ____ Make ____ filter ____ Set ____ effect to ____	Set the value of the sepia filter on the person to light Change gray scale effect on all images to heavy Make morph filter light Set saturate effect to heavy
	Remove Filter	*name	Canvas image, Entity, Region, Image tile	Remove the canvas ____ effect Delete the ____ filter on ____ Delete the ____ effect on this Remove all filters	Remove the canvas morph effect Delete the sepia filter on the dog Delete the sepia effect on this Remove all filters
Style	Fill Color	*color	Shape	Update the fill color on ____ to ____ Change the color of ____ to ____ Fill ____ Set fill to ____	Update the fill color on all rectangles to blue Change the color of the rectangle to red Fill orange Set fill to blue
	Border Color	*color	Shape	Change the border color of __ to __ Set the stroke of ____ to ____ Make the stroke of this ____ Color stroke ____	Change the border color of the rectangles to green Set the stroke of all rectangles to black Make the stroke of this red Color stroke green
	Border Size	*width	Shape	Update stroke size of ____ to ____ Change the border thickness of _ to _ Make stroke width ____ Set the border size of this to ____	Update stroke size of all rectangles to eight Change the border thickness of the rectangle to five Make stroke width eight Set the border size of this to five
Delete			Image tile, Region, Shape	Delete ____ from the canvas Delete ____ Delete Delete this	Delete all drawn regions from the canvas Delete all images Delete Delete this
Label		*newLabel	Entity, Image tile, Region, Shape	Set the label to ____ Label this a ____	Set the label to sunny region Label this as Ross
Copy		copyCount	Image tile, Shape	Create a copy of ____ Make __ copies of __ on the canvas Create a copy Make ____ copies	Create a copy of the image Make two copies of all rectangles on the canvas Create a copy Make six copies
Activate Tool		*toolName	Entity, Image tile, Region, Shape	Set the label to ____ Label this a ____	Set the label to sunny region Label this as Ross
Insert Shape		fillColor, strokeColor, strokeWidth	Canvas image	Add a rectangle on the canvas Add a rectangle with fill _ and stroke _	Add a rectangle on the canvas Add a rectangle with fill red and stroke orange

FIG. 3.

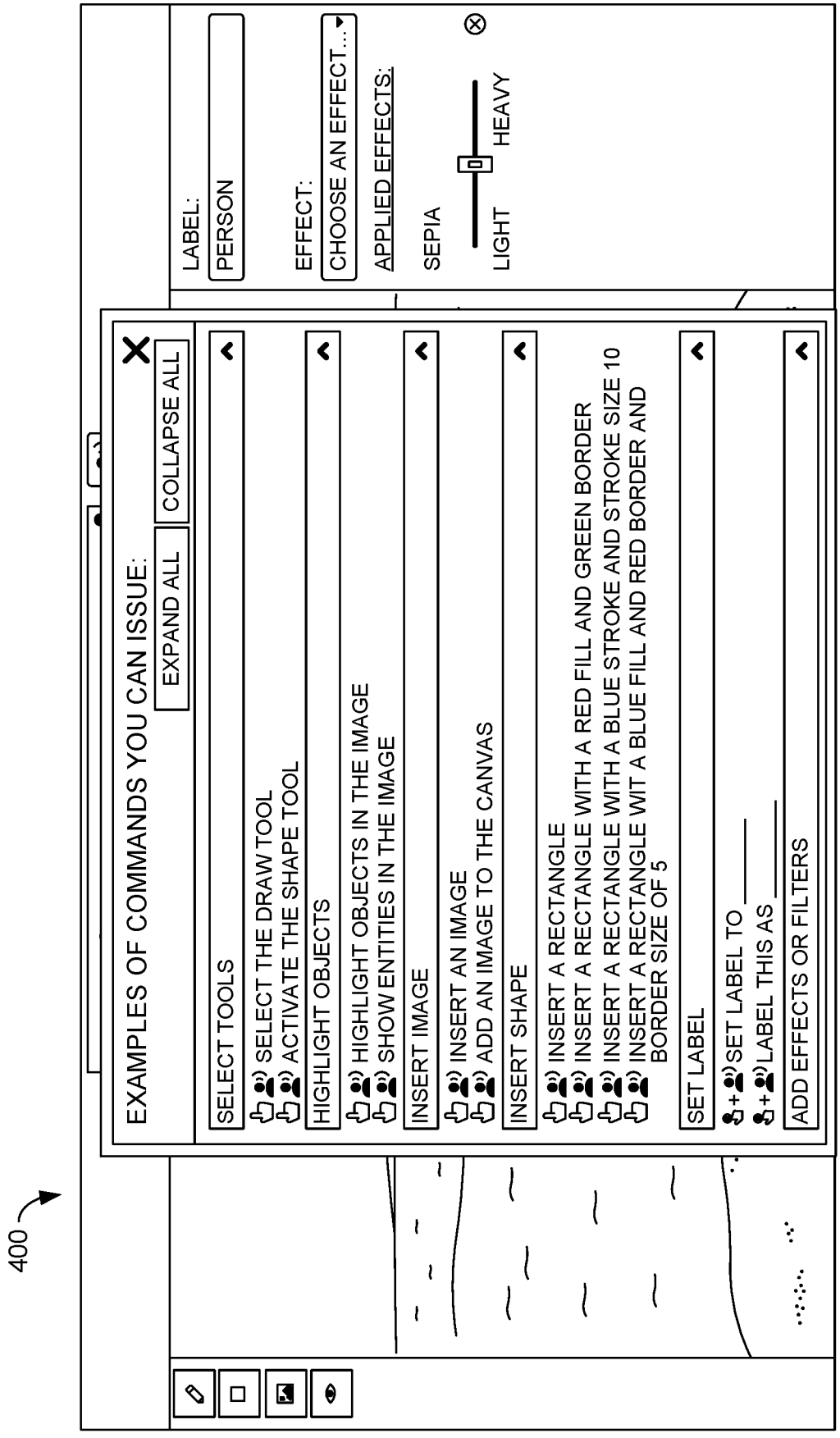
400
EXAMPLES OF COMMANDS YOU CAN ISSUE:
EXPAND ALL
COLLAPSE ALL
SELECT TOOLS
SELECT THE DRAW TOOL
ACTIVATE THE SHAPE TOOL
HIGHLIGHT OBJECTS
HIGHLIGHT OBJECTS IN THE IMAGE
SHOW ENTITIES IN THE IMAGE
INSERT IMAGE
INSERT AN IMAGE
ADD AN IMAGE TO THE CANVAS
INSERT SHAPE
INSERT A RECTANGLE
INSERT A RECTANGLE WITH A RED FILL AND GREEN BORDER
INSERT A RECTANGLE WITH A BLUE STROKE AND STROKE SIZE 10
INSERT A RECTANGLE WIT A BLUE FILL AND RED BORDER AND BORDER SIZE OF 5
SET LABEL
SET LABEL TO ____
LABEL THIS AS ____
ADD EFFECTS OR FILTERS
LABEL:
PERSON
EFFECT:
CHOOSE AN EFFECT...
APPLIED EFFECTS:
SEPIA
LIGHT
HEAVY

FIG. 4.

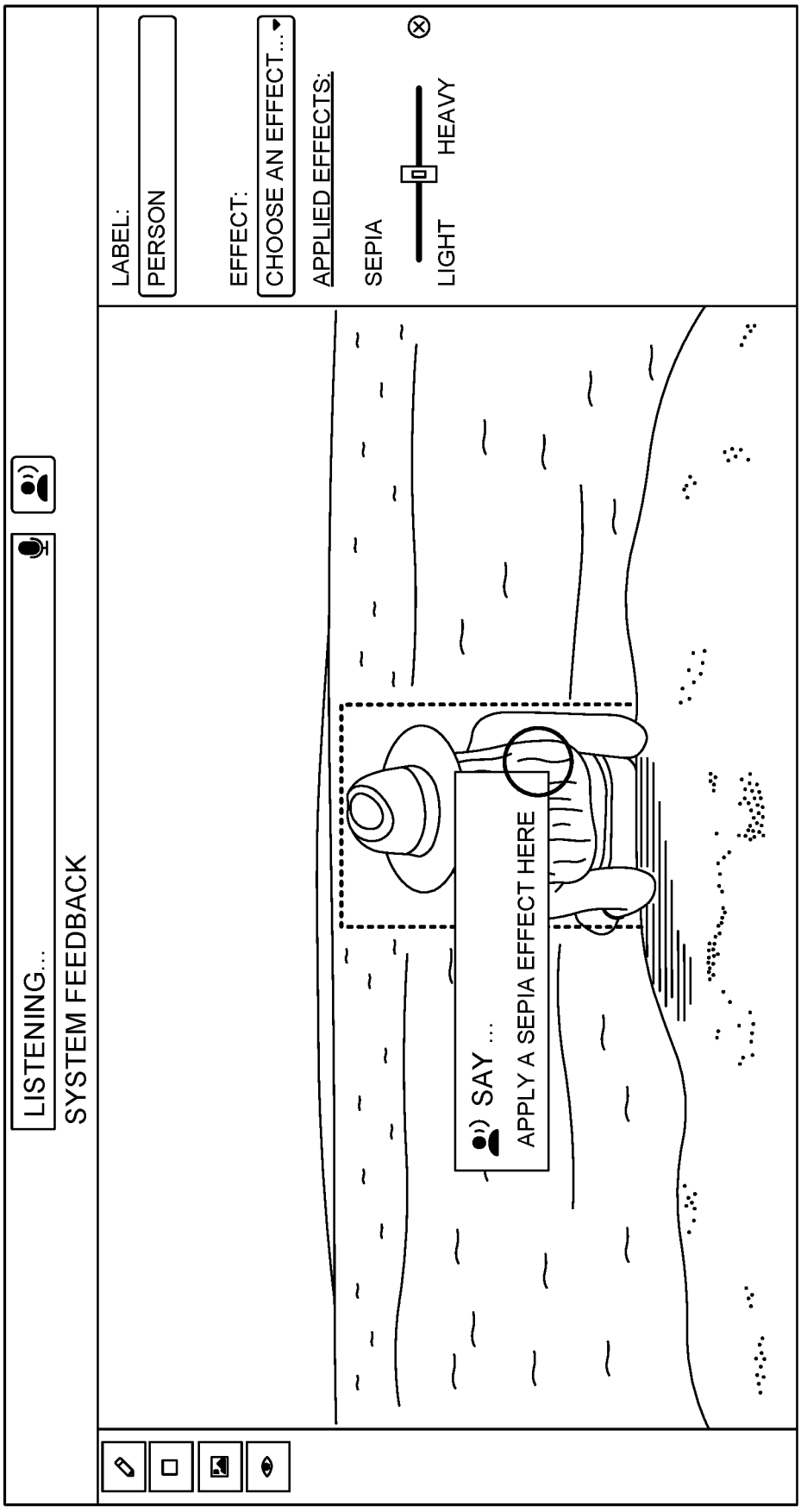
LISTENING...
SYSTEM FEEDBACK
LABEL:
PERSON
EFFECT:
CHOOSE AN EFFECT...
APPLIED EFFECTS:
SEPIA
LIGHT
HEAVY
SAY ...
APPLY A SEPIA EFFECT HERE

FIG. 5A.

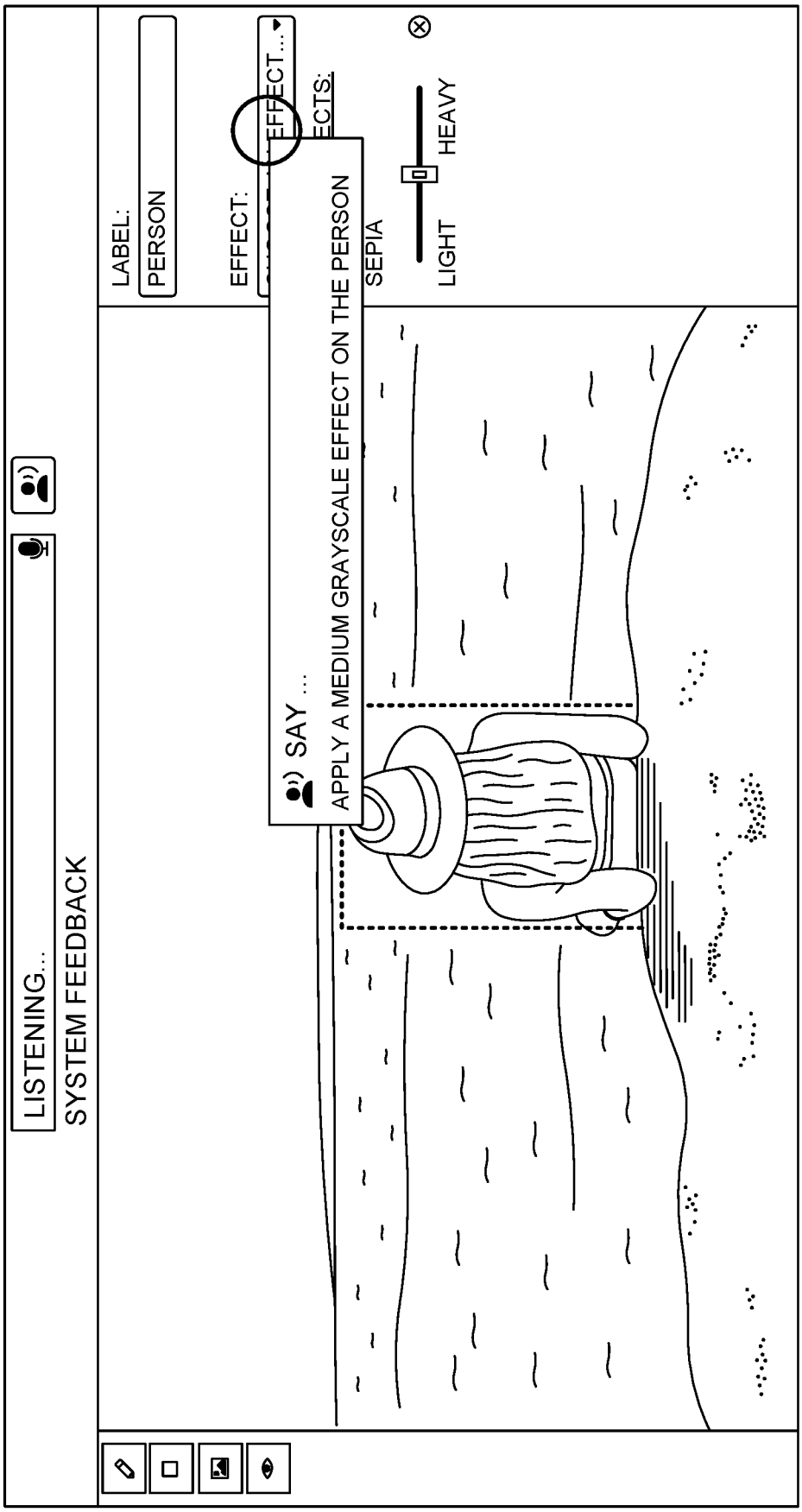
LISTENING...
SYSTEM FEEDBACK
LABEL:
PERSON
EFFECT:
ECTS:
SEPIA
LIGHT
HEAVY
SAY ...
APPLY A MEDIUM GRAYSCALE EFFECT ON THE PERSON

FIG. 5B.

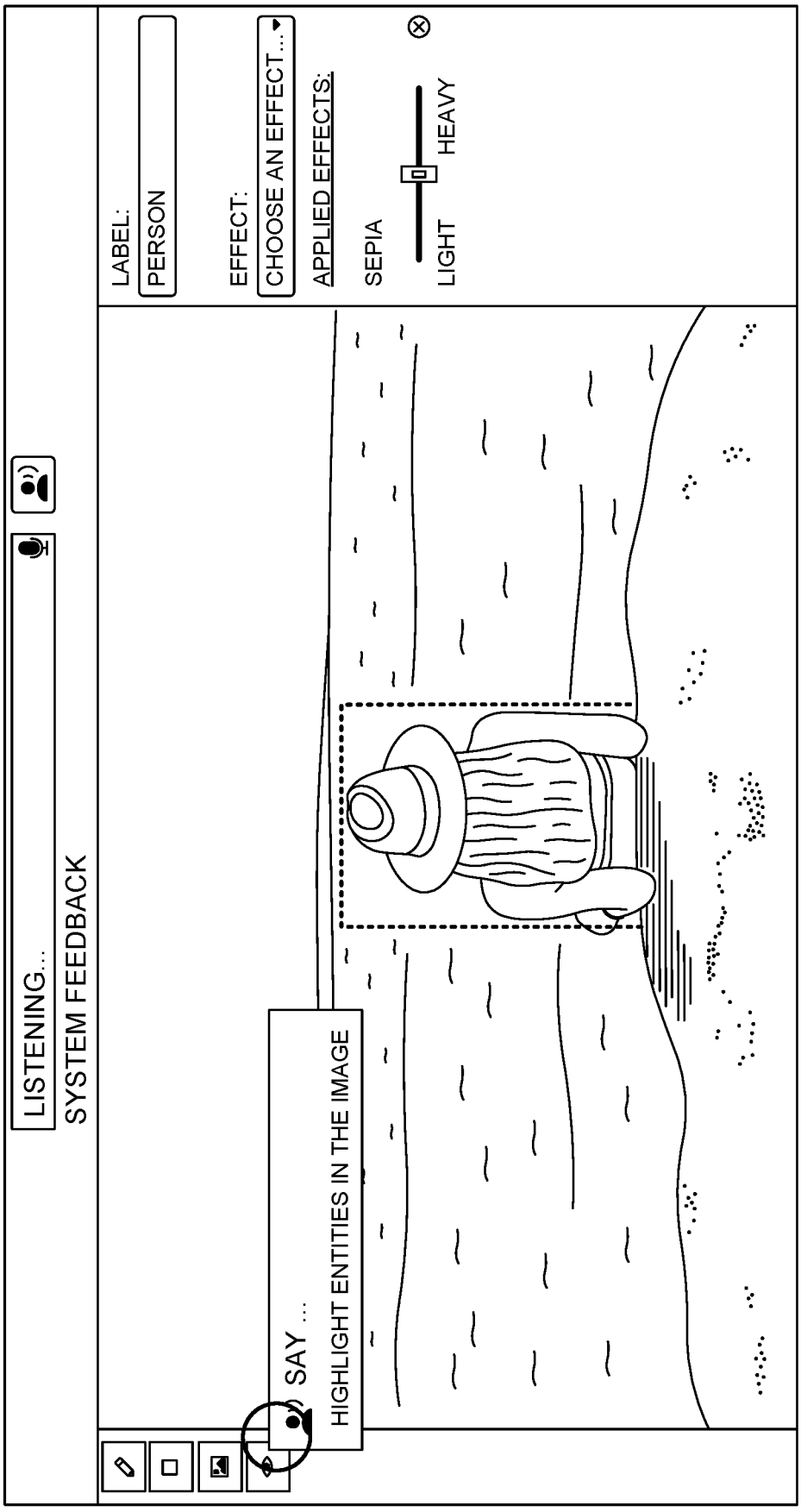
LISTENING...
SYSTEM FEEDBACK
SAY ...
HIGHLIGHT ENTITIES IN THE IMAGE
LABEL:
PERSON
EFFECT:
CHOOSE AN EFFECT...
APPLIED EFFECTS:
SEPIA
LIGHT
HEAVY

FIG. 5C.

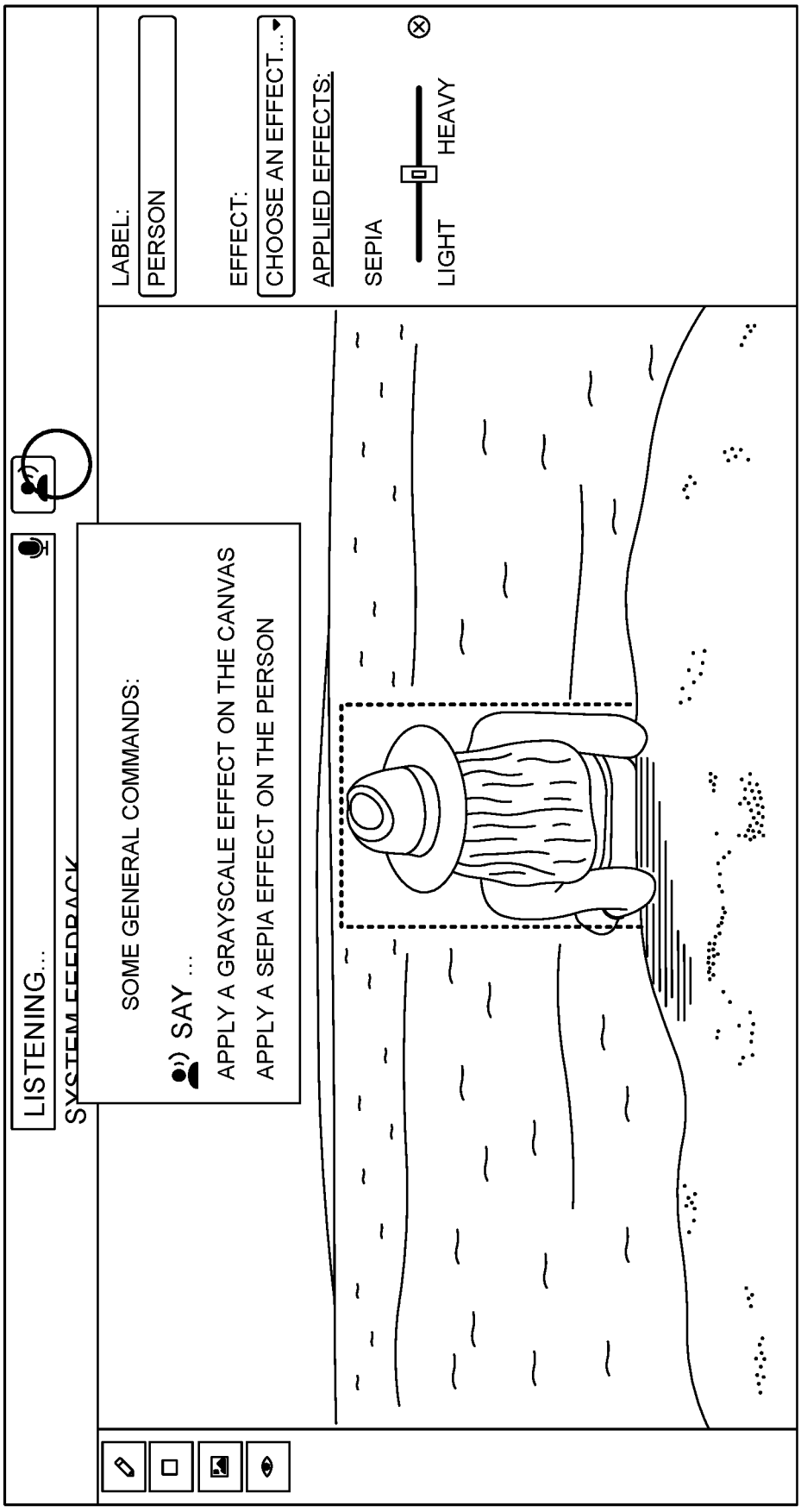
LISTENING...
SYSTEM FEEDBACK
SOME GENERAL COMMANDS:
SAY ...
APPLY A GRAYSCALE EFFECT ON THE CANVAS
APPLY A SEPIA EFFECT ON THE PERSON
LABEL:
PERSON
EFFECT:
CHOOSE AN EFFECT...
APPLIED EFFECTS:
SEPIA
LIGHT
HEAVY

FIG. 5D.

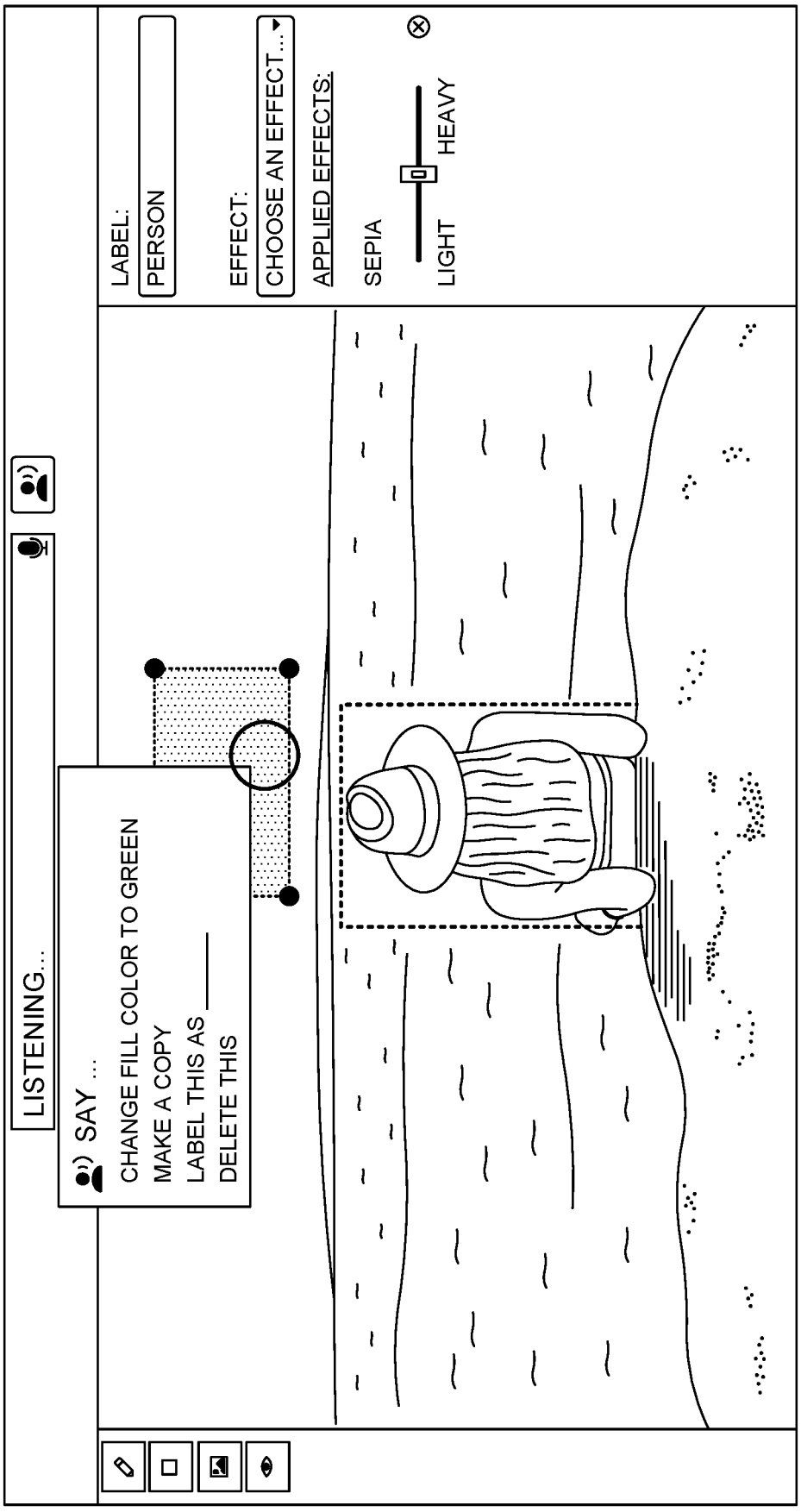
LISTENING...
SAY ...
CHANGE FILL COLOR TO GREEN
MAKE A COPY
LABEL THIS AS ____
DELETE THIS
LABEL:
PERSON
EFFECT:
CHOOSE AN EFFECT...
APPLIED EFFECTS:
SEPIA
LIGHT
HEAVY

FIG. 5E.

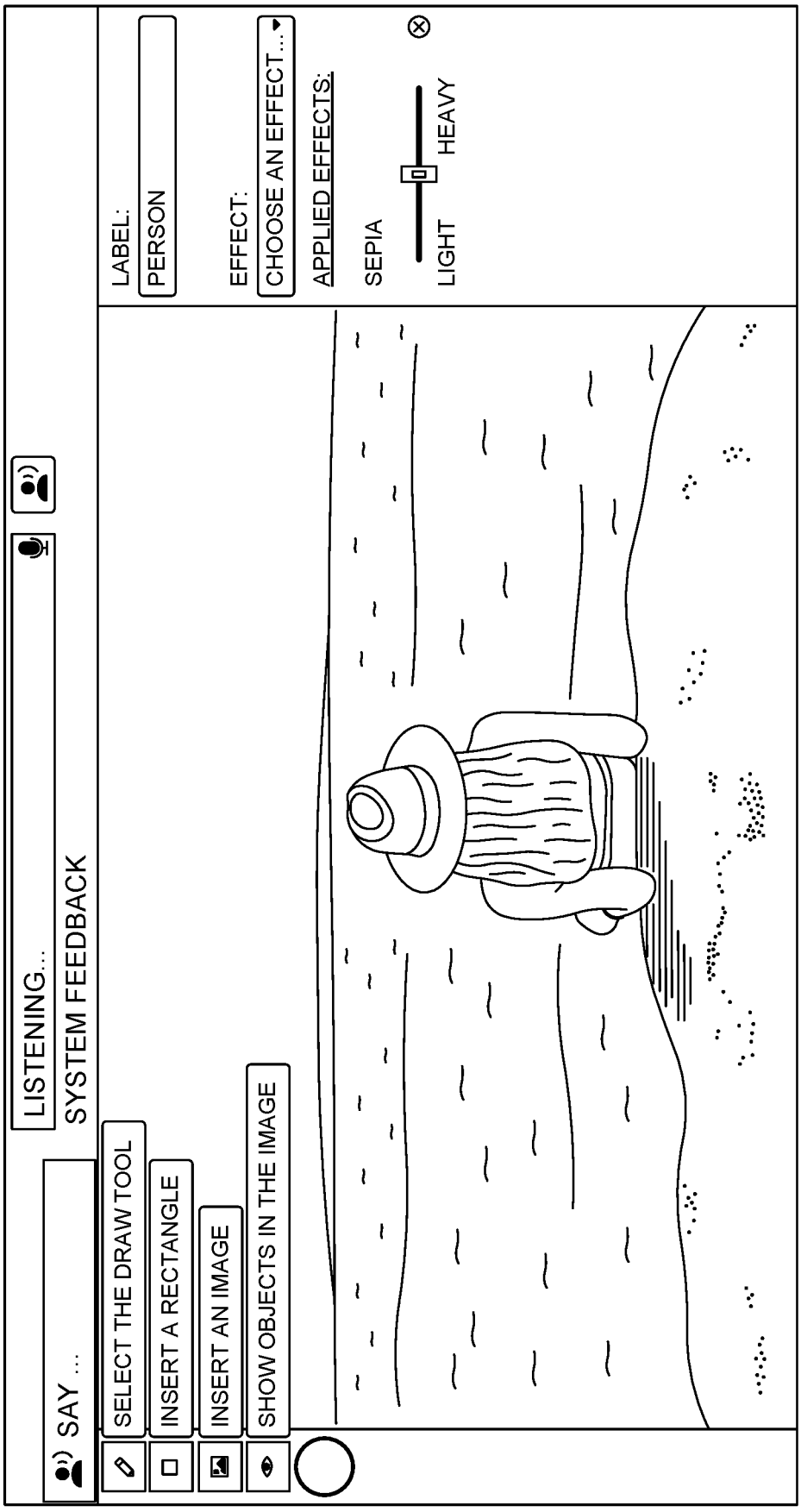
SAY ...
LISTENING...
SYSTEM FEEDBACK
SELECT THE DRAW TOOL
INSERT A RECTANGLE
INSERT AN IMAGE
SHOW OBJECTS IN THE IMAGE
LABEL:
PERSON
EFFECT:
CHOOSE AN EFFECT...
APPLIED EFFECTS:
SEPIA
LIGHT
HEAVY

FIG. 6A.

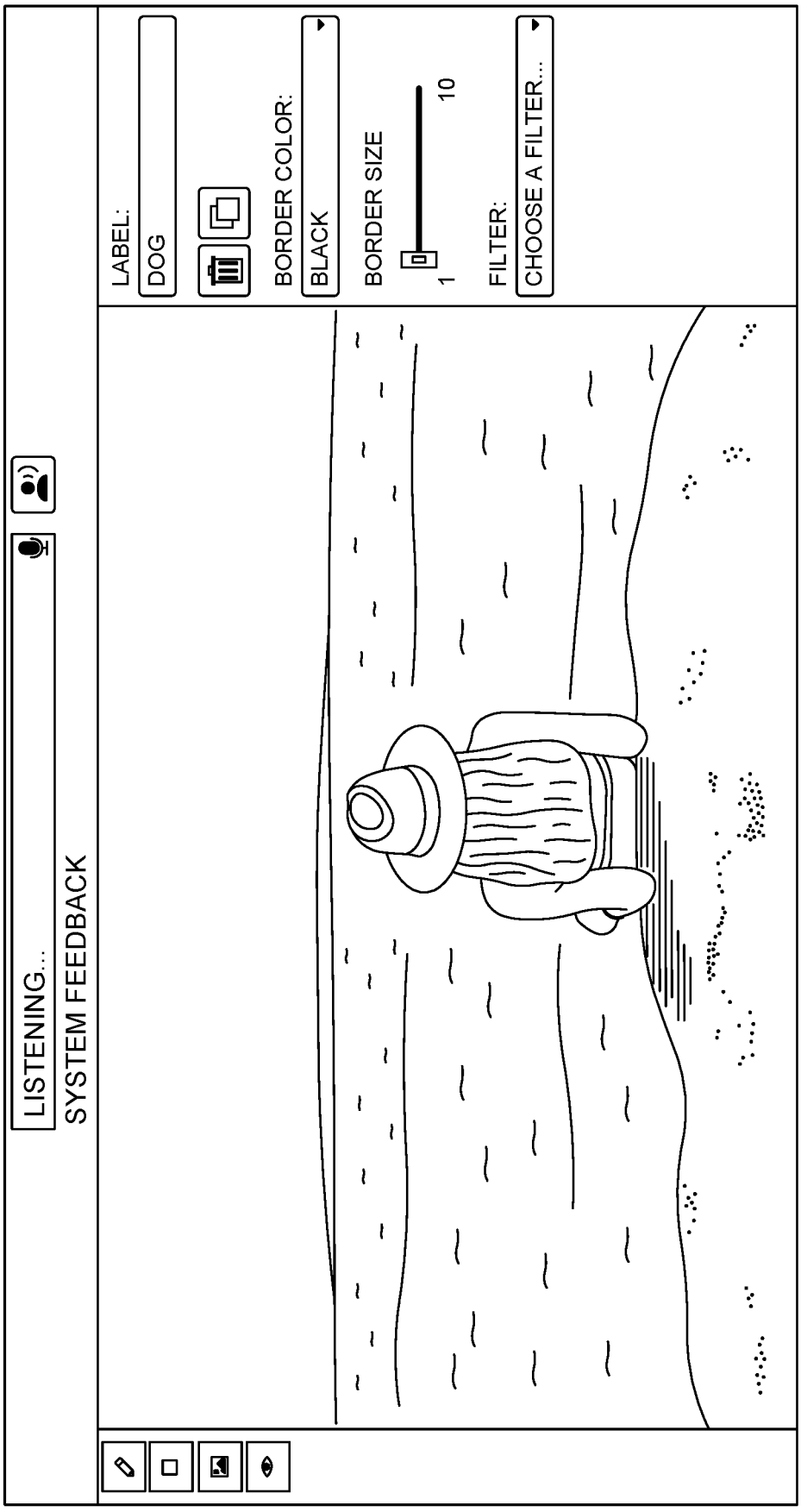
LISTENING...
SYSTEM FEEDBACK
LABEL:
DOG
BORDER COLOR:
BLACK
BORDER SIZE
1
10
FILTER:
CHOOSE A FILTER...

FIG. 6B.

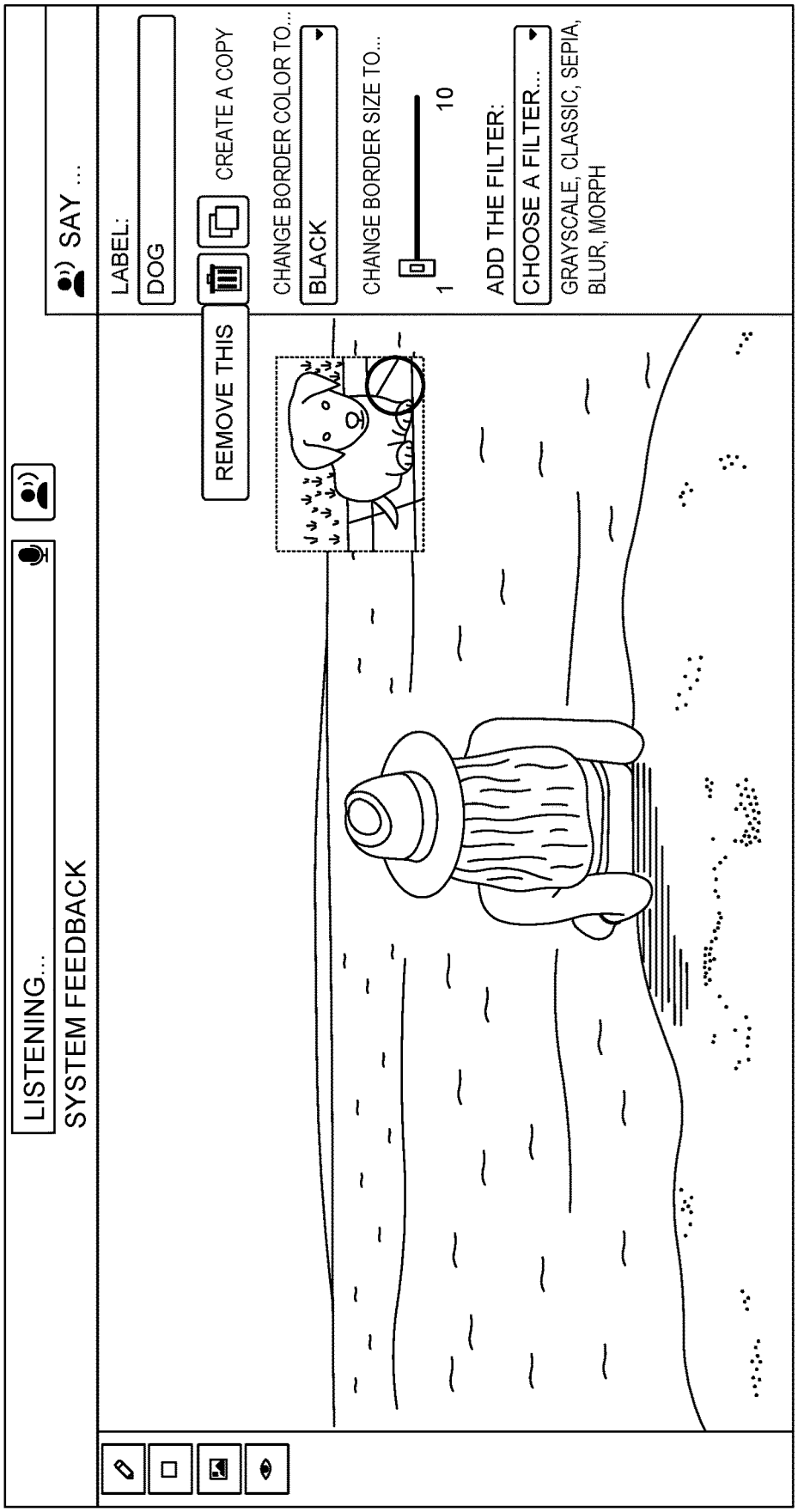
LISTENING...
SYSTEM FEEDBACK
SAY ...
LABEL:
DOG
REMOVE THIS
CREATE A COPY
CHANGE BORDER COLOR TO...
BLACK
CHANGE BORDER SIZE TO...
1
10
ADD THE FILTER:
CHOOSE A FILTER...
GRAYSCALE, CLASSIC, SEPIA, BLUR, MORPH

FIG. 6C.

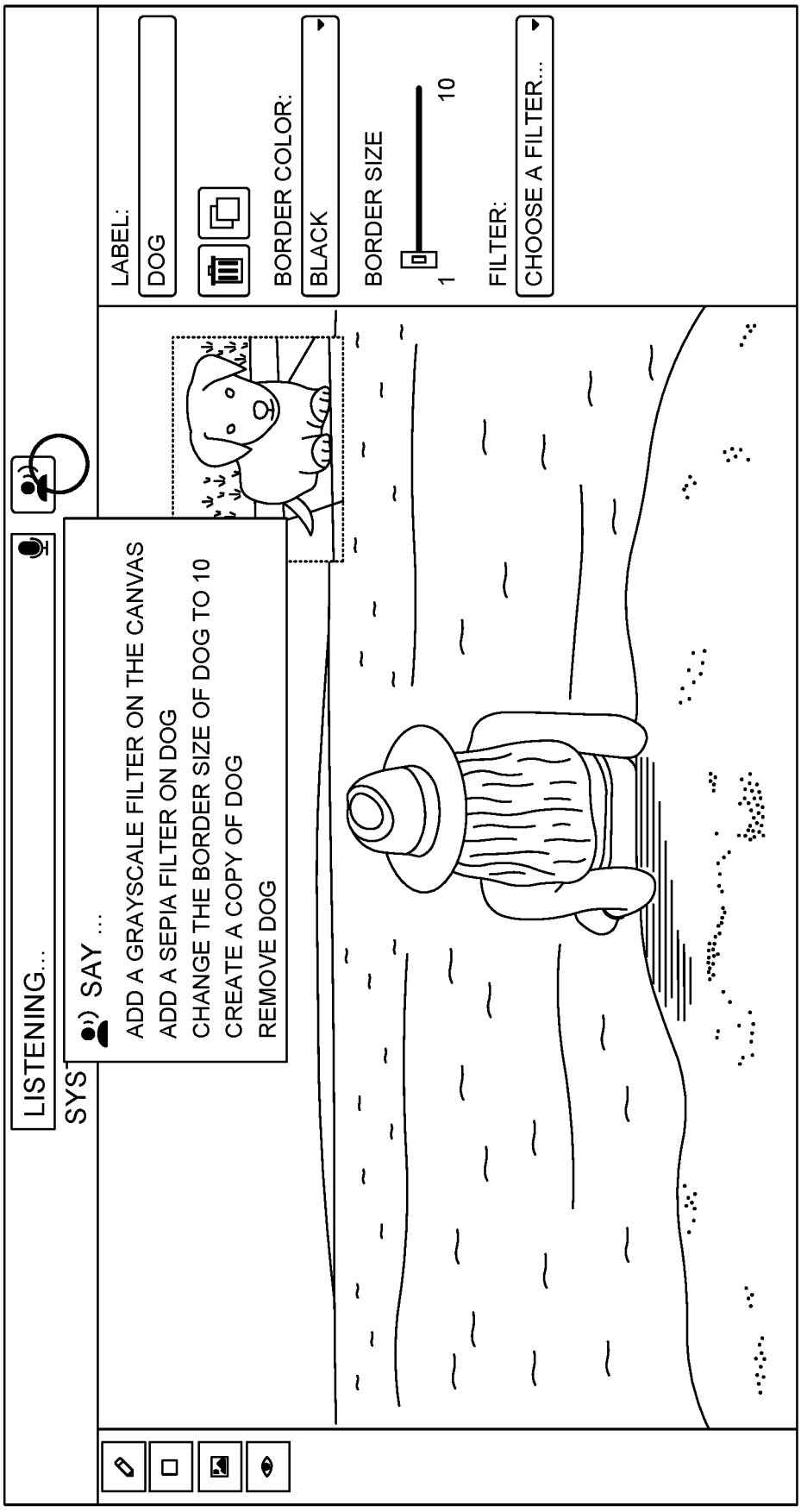
LISTENING...
SYS
SAY ...
ADD A GRAYSCALE FILTER ON THE CANVAS
ADD A SEPIA FILTER ON DOG
CHANGE THE BORDER SIZE OF DOG TO 10
CREATE A COPY OF DOG
REMOVE DOG
LABEL:
DOG
BORDER COLOR:
BLACK
BORDER SIZE
1
10
FILTER:
CHOOSE A FILTER...

FIG. 6D.

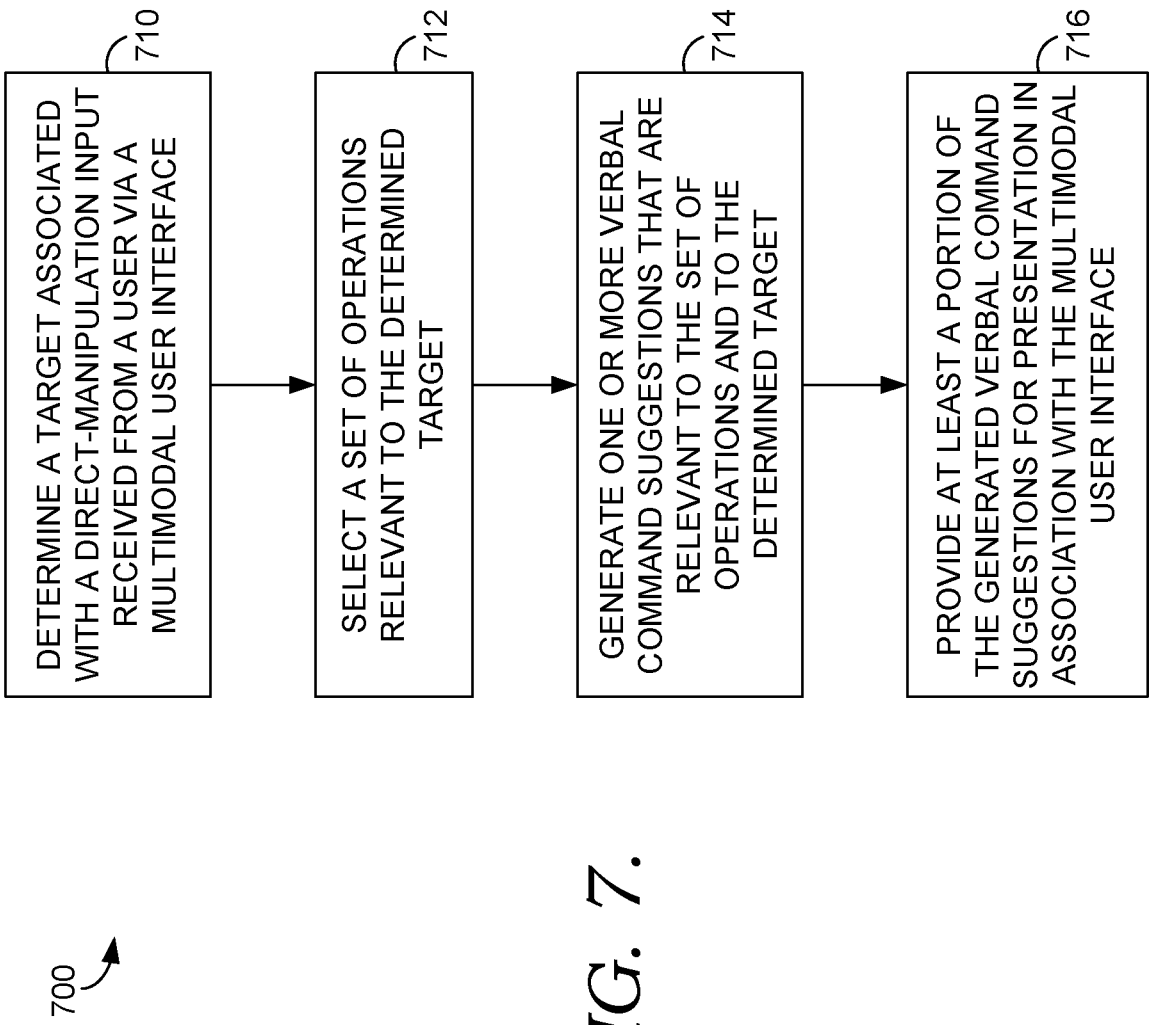
700
DETERMINE A TARGET ASSOCIATED WITH A DIRECT-MANIPULATION INPUT RECEIVED FROM A USER VIA A MULTIMODAL USER INTERFACE
710
SELECT A SET OF OPERATIONS RELEVANT TO THE DETERMINED TARGET
712
GENERATE ONE OR MORE VERBAL COMMAND SUGGESTIONS THAT ARE RELEVANT TO THE SET OF OPERATIONS AND TO THE DETERMINED TARGET
714
PROVIDE AT LEAST A PORTION OF THE GENERATED VERBAL COMMAND SUGGESTIONS FOR PRESENTATION IN ASSOCIATION WITH THE MULTIMODAL USER INTERFACE
716

FIG. 7.

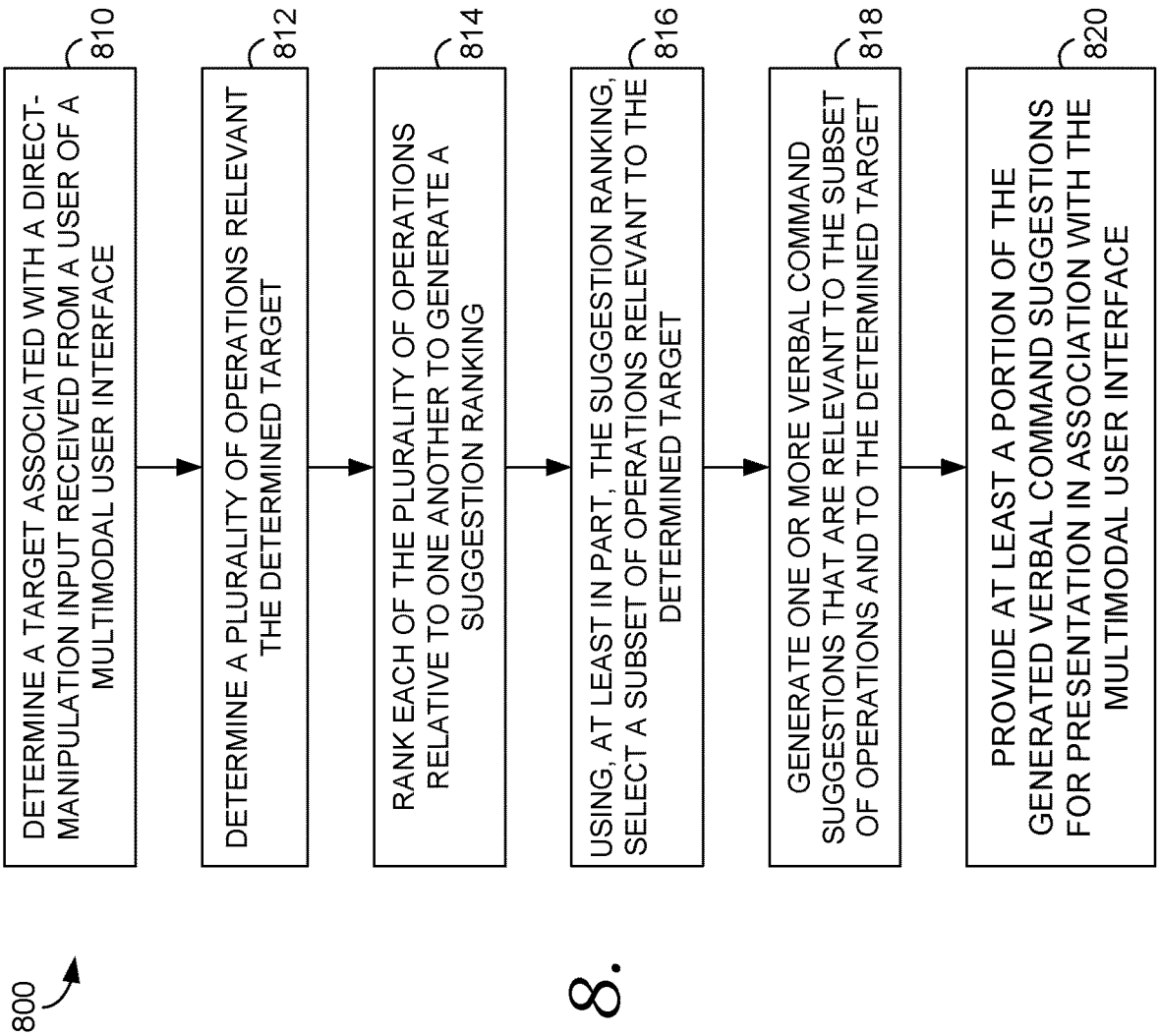
800
DETERMINE A TARGET ASSOCIATED WITH A DIRECT-MANIPULATION INPUT RECEIVED FROM A USER OF A MULTIMODAL USER INTERFACE
810
DETERMINE A PLURALITY OF OPERATIONS RELEVANT THE DETERMINED TARGET
812
RANK EACH OF THE PLURALITY OF OPERATIONS RELATIVE TO ONE ANOTHER TO GENERATE A SUGGESTION RANKING
814
USING, AT LEAST IN PART, THE SUGGESTION RANKING, SELECT A SUBSET OF OPERATIONS RELEVANT TO THE DETERMINED TARGET
816
GENERATE ONE OR MORE VERBAL COMMAND SUGGESTIONS THAT ARE RELEVANT TO THE SUBSET OF OPERATIONS AND TO THE DETERMINED TARGET
818
PROVIDE AT LEAST A PORTION OF THE GENERATED VERBAL COMMAND SUGGESTIONS FOR PRESENTATION IN ASSOCIATION WITH THE MULTIMODAL USER INTERFACE
820

FIG. 8.

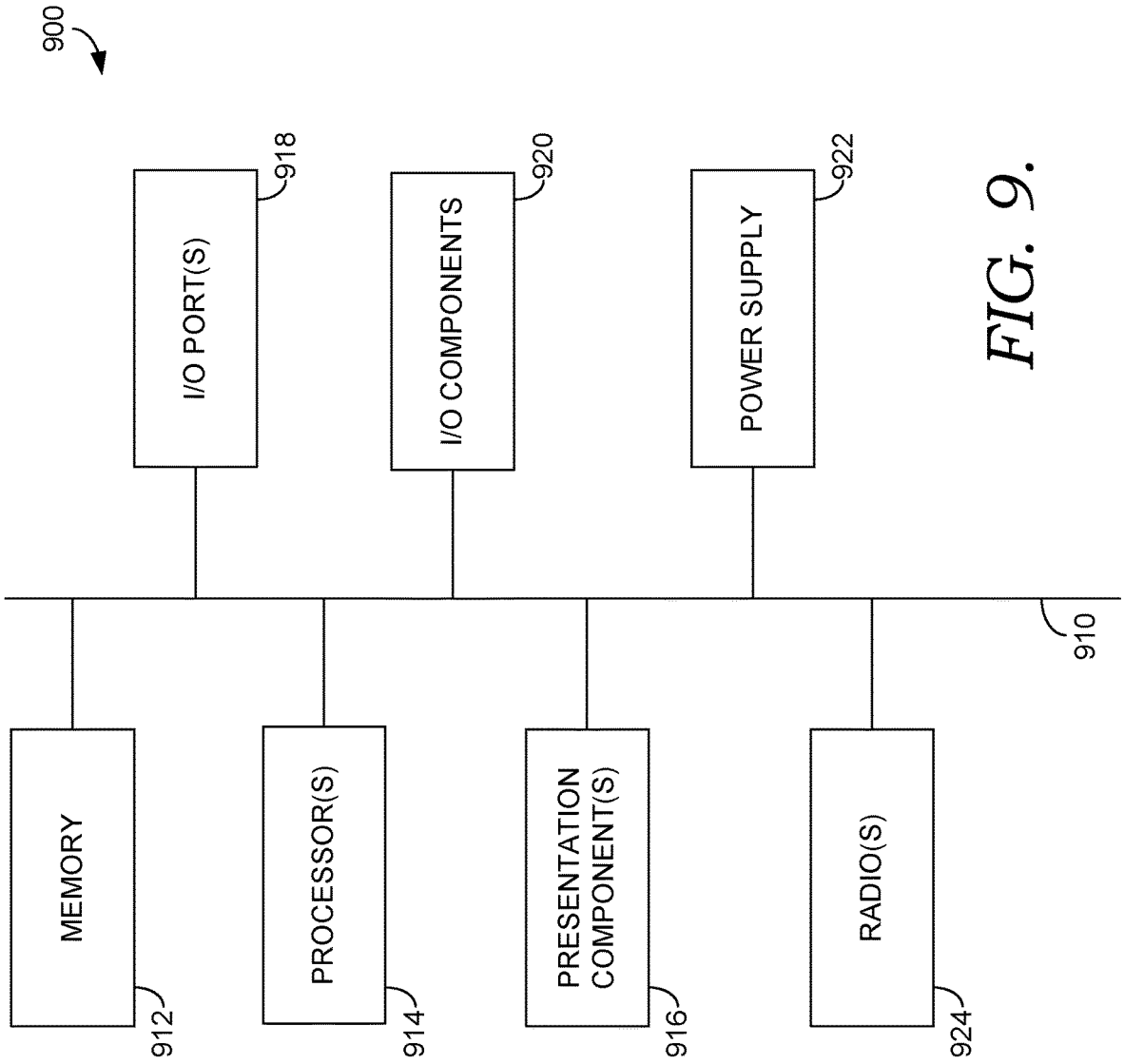
900
I/O PORT(S)
918
I/O COMPONENTS
920
POWER SUPPLY
922
910
MEMORY
912
PROCESSOR(S)
914
PRESENTATION COMPONENT(S)
916
RADIO(S)
924

FIG. 9.

FACILITATING DISCOVERY OF VERBAL COMMANDS USING MULTIMODAL INTERFACES

BACKGROUND

Discoverability (awareness and understanding) of appropriate verbal commands represents a long-standing challenge for users of speech-based interfaces. In fact, discoverability, in terms of a user not knowing what verbal commands are available (awareness) and/or how to phrase commands such that they will be understood by the system supporting the interface (understanding), is second only to speech-recognition accuracy issues when it comes to obstacles faced by users of speech-based interfaces. Users often end up guessing at verbal commands that they believe the supporting system might recognize and/or using phraseology or vernacular they are used to but might not be understood by the system, both of which often lead to execution errors and frustration.

One approach to address these challenges of discoverability has been for systems to present users with a list of exemplary commands as part of the onboarding experience, as this is a natural time to expose users to the operations and commands supported by a speech-based system. However, such lists presented during onboarding, when users are not engaged in any particular task or action, often are closed by users before being thoroughly and completely reviewed. Even if a user thoroughly reviews an exemplary command list, the presented commands often are forgotten by the time the user attempts to employ a command while engaging in an action or task.

To make users aware of newly supported and/or infrequently used commands, some solutions send notifications to users to remind them of available commands or when new commands become available. Similarly, some solutions send users weekly emails with available command reminders and updates. However, presenting exemplary command suggestions only periodically is insufficient as users tend to forget these commands by the time they are engaged in performing actions and/or tasks utilizing the speech-based system.

SUMMARY

Embodiments of the present disclosure relate to, among other things, a framework for generating and presenting examples of verbal commands to facilitate discoverability of relevant verbal commands understood by systems that support multimodal interfaces. The framework described herein additionally permits users to incrementally explore available verbal commands. The described framework enables command discoverability by providing exemplary verbal command suggestions when non-verbal (e.g., direct-manipulation) inputs are used. A target associated with a direct-manipulation input (e.g., a touch input, a keyboard input, or a mouse input) received from a user via a multimodal user interface is determined and one or more exemplary verbal command suggestions is generated that are relevant to the target. At least a portion of the generated verbal command suggestions is provided for presentation in association with the multimodal user interface utilizing one of three interface variants. The variants include an interface that presents verbal command suggestions using a list-based approach, an interface that uses contextual overlay windows to present verbal command suggestions, and an interface that presents verbal command suggestions that are embedded within the GUI ("Graphical User Interface"). Each of the proposed interface variants facilitates user awareness of verbal commands that the system supporting the multimodal interface is capable of executing and simultaneously teaches users how available verbal commands can be invoked (e.g., appropriate phrasing variants and multimodal interactions).

This Summary is provided to introduce a selection of concepts in a simplified form that are further described below in the Detailed Description. This Summary is not intended to identify key features or essential features of the claimed subject matter, nor is it intended to be used as an aid in determining the scope of the claimed subject matter.

BRIEF DESCRIPTION OF THE DRAWINGS

The present invention is described in detail below with reference to the attached drawing figures, wherein:

FIG. **1** is a schematic diagram illustrating a high-level overview of a command suggestion generation framework in accordance with implementations of the present disclosure;

FIG. **2** is a block diagram illustrating an exemplary system for facilitating discovery of verbal commands in multimodal user interfaces, in accordance with implementations of the present disclosure;

FIG. **3** is a schematic diagram illustrating an exemplary list of phrasing templates associated with a set of operations that may be selected when a target involves image editing, in accordance with implementations of the present disclosure;

FIG. **4** is an exemplary screen display illustrating an exhaustive interface in accordance with implementations of the present disclosure;

FIGS. **5**A-**5**E depict exemplary screen displays illustrating an adaptive interface in accordance with implementations of the present disclosure;

FIGS. **6**A-**6**D depict exemplary screen displays illustrating an embedded interface in accordance with implementations of the present disclosure;

FIG. **7** is a schematic diagram showing an exemplary method for facilitating discoverability of verbal commands in multimodal interfaces, in accordance with implementations of the present disclosure;

FIG. **8** is a schematic diagram showing an exemplary method for facilitating discoverability of verbal commands in multimodal interfaces, in accordance with implementations of the present disclosure; and

FIG. **9** is a block diagram of an exemplary computing environment suitable for use in implementations of the present disclosure.

DETAILED DESCRIPTION

The subject matter of the present disclosure is described with specificity herein to meet statutory requirements. However, the description itself is not intended to limit the scope of this patent. Rather, the inventors have contemplated that the claimed subject matter also might be embodied in other ways, to include different steps or combinations of steps similar to the ones described in this document, in conjunction with other present or future technologies. Moreover, although the terms "step" and/or "block" may be used herein to connote different elements of methods employed, the terms should not be interpreted as implying any particular order among or between various steps herein disclosed unless and except when the order of individual steps is explicitly described.

Discovering verbal commands that are available and how such verbal commands can be phrased such that they are

understood by a supporting system remains a long-standing challenge for users of natural language interfaces (NLIs). Improvements in speech-to-text engines and the prevalence of commercial speech interfaces as part of speech-only and multimodal solutions have introduced more end-users to this modality. However, the "invisible" nature of speech (and other verbal inputs), relative to other GUI elements, makes it particularly challenging for users to learn and adopt. Discoverability in this context entails not only making users aware of the operations that can be performed using verbal commands (i.e., awareness) but also educating users on how verbal commands should be phrased so that the system can interpret them correctly (i.e., understanding). Lack of support for discovery of verbal commands often results in users having to guess at supported verbal commands and/or phrasings. However, because guesses are more likely to be misinterpreted, causing increased errors, users that have been exposed to such systems may be discouraged from using verbal input altogether, regardless of the system being employed by a user.

Multimodal interfaces supporting verbal input and at least one form of direct manipulation input (e.g., touch input, keyboard input, mouse input, eye-tracking, in-air gestures, or the like) offer an advantage over speech-only interfaces. As multiple input modalities can provide complementary strengths, direct manipulation input can help people use verbal input more effectively and vice-versa. For example, in a multimodal document reader, a speech-only interface may make it hard for a user to ask for the appropriate pronunciation of a word. A user would need to guess the pronunciation of the same word that s/he wants the system to pronounce. With a multimodal interface supporting, by way of example only, speech and touch, a user can point to a word and ask for its pronunciation. Conversely, verbal input can aid interfaces that accept direct manipulation input. For instance, rather than learning where and how to invoke operations within a GUI, the user could simply point at a word and say, "pronounce this." As applications begin to support more intelligence (e.g., entity recognition in images), the opportunity for multimodal interaction grows. For example, in a multimodal image editor, a user can point to a person in an image and issue the command "remove shadow on face." However, the question remains: how does a user discover what they can say and how to say it?

Embodiments of the present disclosure address the challenges of educating users of multimodal user interfaces on what commands they can say to invoke their desired outcomes and the appropriate manner of inputting such commands (e.g., phraseology and the like) such that the system supporting the multimodal interface understands their desired outcomes. To this end, embodiments of the present disclosure facilitate discovery of verbal commands (e.g., natural language verbal commands) in multimodal user interfaces by permitting users to interactively select targets via a direct-manipulation modality (e.g., touch, keyboard, mouse, etc.) and, in response, presenting exemplary verbal commands in association with the multimodal user interface. In this way, non-speech modalities can help the user focus the high level question "What can I say?" to a more particular "What can I say here and now?" Embodiments hereof further facilitate discovery of verbal commands in multimodal user interfaces by providing relevant command suggestions in direct, temporal association with the interface by presenting exemplary verbal command suggestions in the interface while it is being utilized by the user. Contemplated are three interface variants. A first variant is an interface that presents suggestions using a list-based approach (referred to herein as an "exhaustive" interface). A second variant is an interface that uses contextual overlay windows to present suggestions (referred to herein as an "adaptive" interface). A third variant is an interface that embeds commands within the GUI (referred to herein as an "embedded" interface). The interface variants facilitate making users aware of what operations the system supporting the multimodal user interface is capable of executing and simultaneously teaches them how available verbal commands can be invoked (e.g., appropriate phrasing variants and multimodal interactions).

With reference now to the drawings, FIG. **1** is a schematic diagram illustrating a high-level overview of a command suggestion generation framework **100** in accordance with implementations of the present disclosure. Given a target (i.e., a region of a multimodal user interface that is the object of a direct-manipulation input) for which verbal commands are to be suggested, the framework iterates through a listing or catalog of available operations **110** (i.e., system actions that are capable of being performed) for the target. A subset of operations for which exemplary verbal command suggestions are to be generated is selected **112**. Such selection may be based upon, by way of example only, one or more of a type associated with the target **114**, relevance of an operation to a workflow engaged in by the user **116**, the number of times a verbal command has been issued for an operation for the user (or for a set of users, e.g., all users)**118** ("operation issued-count") and the number of times an operation previously has been presented in suggested commands for the user (or for a set of users, e.g., all users) **120** ("operation shown-count").

For the selected operations, the system then traverses through a predefined listing or catalog of phrasing templates **122** and selects **124** at least one to present. Such template phrasing selection may be based upon, by way of example only, one of more of a type associated with the received direct-manipulation input **126** (i.e., how the input leading to verbal command suggestion generation was invoked), complexity of the phrasing template **128** (i.e., the number of parameters needed to complete the template), the number of times a phrasing template has been issued for the selected operation for a particular user (or for a set of users, e.g., all users) **130** ("template issued-count") and the number of times the phrasing template has been presented in suggested commands for a particular user (or for a set of users, e.g., all users) **132** ("template shown-count").

Finally the framework populates **134** any modifiable parameters (i.e., characteristics for which more than one value may be appropriate such as color names, filter names, tool names, and the like) included in the selected templates with sample parameter values in order to generate **136** the final exemplary verbal command suggestions to be provided for presentation to the user. The modifiable parameters may be populated based upon, by way of example only, one or more of relevance to a workflow engaged in by the user **138** and an active state of the target **140**.

Turning to FIG. **2**, a block diagram is shown illustrating an exemplary system **200** for facilitating discovery of natural language commands in multimodal user interfaces. It should be understood that this and other arrangements described herein are set forth only as examples. Other arrangements and elements (e.g., machines, interfaces, functions, orders, and groupings of functions, etc.) can be used in addition to or instead of those shown, and some elements may be omitted altogether. Further, many of the elements described herein are functional entities that may be implemented as discrete or distributed components or in conjunction with other components, and in any suitable combination

and location. Various functions described herein as being performed by one or more entities may be carried out by hardware, firmware, and/or software. For instance, various functions may be carried out by a processor executing instructions stored in memory.

The system **200** is an example of a suitable architecture for implementing certain aspects of the present disclosure. Among other components not shown, the system **200** includes a user computing device **210** interacting with a verbal command discovery engine **212** to facilitate discovery of verbal commands using multimodal user interfaces. Each of the components shown in FIG. **2** can be provided on one or more computing devices, such as the computing device **900** of FIG. **9**, discussed below. As shown in FIG. **2**, the user computing device **210** and the verbal command discovery engine **212** can communicate via a network **214**, which may include, without limitation, one or more local area networks (LANs) and/or wide area networks (WANs). Such networking environments are commonplace in offices, enterprise-wide computer networks, intranets, and the Internet. It should be understood that any number of user devices and verbal command discovery engines may be employed within the system **200** within the scope of the present disclosure. Each may comprise a single device or multiple devices cooperating in a distributed environment. For instance, the verbal command discovery engine **212** could be provided by multiple server devices collectively providing the functionality of the verbal command discovery engine **212** as described herein. Additionally, other components not shown also may be included within the network environment.

The verbal command discovery engine **212** generally is configured to facilitate discovery of verbal commands in multimodal user interfaces. Multimodal user interfaces are user interfaces that support more than one mode of input. In aspects hereof, exemplary multimodal interfaces support verbal input (e.g., speech input) and direct-manipulation input (e.g., input received via touch, a keyboard, eye-tracking, in-air gestures, a mouse, or other non-verbal input). The user device **210** can access and communicate with the verbal command discovery engine **212** via a web browser or other application running on the user computing device **210**. Alternatively, the verbal command discovery engine **212** may be installed on the user computing device **210** such that access via the network **214** is not required.

The verbal command discovery engine **212** includes a direct-manipulation input receiving component **216**, a target determining component **218**, an operations determining component **220**, and operations subset selecting component **222**, a verbal command suggestion generating component **224** and a presenting component **226**. The direct-manipulation input receiving component **216** is configured for receiving direct-manipulation inputs from a user via a multimodal interface associated with the user computing device **210**. Direct-manipulation inputs may include, by way of example only, touch inputs, keyboard inputs, mouse click inputs, and hover inputs.

The target determining component **218** is configured for determining a target associated with a received direct-manipulation input. A target is a region of a multimodal user interface that is the object of a direct-manipulation input. Thus a target may be an object, application, user interface element, image, text, or the like that is located in proximity to a location in a multimodal interface from which a direct-manipulation input is received. By way of example, if a received direct-manipulation input is a touch input received in association with an image, the target may be an object in that image (e.g., background image, a person, shape, etc.) that was located under a user's finger when the touch input was received. A target may also be a widget, an icon, a toolbar, a toolbar function, or the like. Thus, by way of example, if a received direct-manipulation input is a mouse-click input received in association with a function indicator located in a tool bar, the target may be the function indicator itself and, accordingly, the corresponding function. Any object, element, application, image, or the like associated with a multimodal interface can be a target when it is associated with a received direct-manipulation input.

The operations determining component **220** is configured for determining a plurality of operations that are available and that are capable of being performed with respect to a target of a direct-manipulation input. The determined list of operations is generally predefined by the system **200** and stored in association with (or in a separate data store (not shown) accessible by) the verbal command discovery engine **212**. The operations subset selecting component **222** is configured for selecting a subset of the operations determined by the operations determining component **220** for which to focus generated verbal command suggestions. Selecting an appropriate subset of operations may be based on a number of factors. A first exemplary factor may be relevance of an operation to the type of target for which suggested verbal commands are being generated (**114** of FIG. **1**). For example, in generating verbal command suggestions relevant to a shape presented on the multimodal interface, the system **200** likely would select the "fill color" operation as it would be relevant to the type of target (e.g., the shape) and likely would not select the "filter" operation as such would be irrelevant to the target type.

A second exemplary factor may be relevance of an operation to a workflow engaged in by the user (**116** of FIG. **1**). A "workflow," as the term is utilized herein, is a set of operations that help a user accomplish a task or action. Workflows generally are predefined by the system **200** but also may be defined by a user. For instance, if a user is engaged in a workflow using an image editing application to alter a color image by making it black and white and changing a border color from black to white, a relevant workflow may involve the operations "Apply a grayscale filter" and "Change the border color to white." In embodiments of the present disclosure, if the system **200** determines that the user is engaged in a workflow, operations relevant to the workflow may be considered by the operations subset selecting component **222** in selecting the operations subset.

A third exemplary factor that may be used by the operations subset selecting component **222** to select an appropriate subset of operations is issued-count (**118** of FIG. **1**). "Issued count," as the term is utilized herein, refers to the number of times a verbal command has been issued for an operation for a particular user (or, in some embodiments, for a set of users, e.g., all users). In some embodiments, operations for which verbal commands are frequently issued may be given priority as such operations may represent actions frequently engaged in by users in association with the determined target. In other embodiments, operations for which verbal commands are infrequently issued may be given priority as such may educate the user as to operations that can be performed by the system **200**.

A fourth exemplary factor that may be used by the operations subset selecting component **222** to select an appropriate subset of operations is shown-count (**120** of FIG. **1**). "Shown-count," as the term is utilized herein, refers to the number of times an operation previously has been presented in verbal command suggestions for a particular

user (or, in some embodiments, for a set of users, e.g., all users). In some embodiments, operations for which verbal commands are frequently presented may be given priority as such operations may represent actions frequently engaged in by users in association with the determined target. In some embodiments, operations for which verbal commands are infrequently presented may be given priority as such may educate the user as to operations that are capable of being performed by the system **200**.

The operations subset selecting component **222** includes an operations ranking component **228**. The operations ranking component **228** is configured for ranking operations comprising a plurality of operations relative to one another to generate a suggestion ranking. In embodiments, one or more of the factors previously set forth (i.e., target type, workflow relevance, issued-count, and shown-count) may be utilized by the operations ranking component **228** for generating the suggestion ranking in accordance with a predetermined set of priority rules. Once a suggestion ranking is generated, the operations subset selecting component **222** is configured to utilize the suggestion ranking, at least in part, to select a subset of operations on which generated verbal command suggestions will be focused.

The verbal command suggestion generating component **224** is configured for generating a plurality of verbal command suggestions that are relevant to a subset of operations selected by the operations subset selecting component **222**. The verbal command suggestion generating component **224** includes a phrasing template selecting component **230**, a phrasing template subset selecting component **232** and a parameter populating component **234**. Phrasing templates generally are predefined by the system **200** though, in some embodiments, they may be predefined by a user. By way of example only, FIG. **3** illustrates a list of phrasing templates associated with a set of operations that may be selected by the operations subset selecting component **222** when a target involves image editing. It will be understood and appreciated by those having ordinary skill in the art that such listing is intended only to be exemplary and not to limit embodiments hereof in any way. Similarly, it will be understood and appreciated that the framework and system described herein are not specific to image editing tools and can be used by other multimodal systems to enhance verbal command discoverability.

The phrasing template selecting component **230** is configured for selecting, generally through traversing through a predefined list of phrasing templates, a plurality of phrasing templates that are relevant to a subset of operations selected by the operations subset selecting component **222**. The phrasing template subset selecting component **232** is configured for selecting a phrasing template for each operation comprising the selected subset of operations. In embodiments, the phrasing template subset selecting component **232** may consider four exemplary factors when selecting phrasing templates. The first exemplary factor is the type of input received (**126** of FIG. **1**), that is, the manner in which the direct-manipulation input leading to verbal command suggestion generation was invoked. A second exemplary factor is the complexity of the phrasing template (**128** of FIG. **1**) as evidenced by the number of parameters that are required to complete the template. In some embodiments, the default of the system **200** is to select phrasing templates having the lowest complexity (that is, the lowest number of modifiable parameters). In embodiments, whenever an operation is performed by a user more than once, the complexity of selected phrasing templates may be increased, for instance, by one parameter until a pre-defined maximum number of parameters has been reached. Thus, in embodiments, users are incrementally exposed to complex verbal commands as they learn to perform basic operations.

A third exemplary factor is the issued-count (**130** of FIG. **1**), that is, the number of times a phrasing template has been issued for the selected operation for a particular user (or for a set of users, e.g., all users). A fourth exemplary factor is the shown-count (**132** of FIG. **1**), that is, the number of times the phrasing template has been shown to a particular user (or to a set of users, e.g., all users). In some embodiments, phrasings with low issued-count and low shown-count are ranked higher than those with high issued-count and high shown-count.

Often, phrasing templates include at least one modifiable parameter. As such, the parameter populating component **234** of the verbal command suggestion generating component **224** is configured for populating phrasing templates having parameters with exemplary parameter values. In embodiments, if the verbal command discovery engine **212** determines that the user is engaged in a workflow, the parameter populating component **234** may select parameter values that are workflow-oriented. In embodiments, the parameter populating component **234** may select parameter values that differ from the target's current state. For instance, if the determined target is a green rectangle, the suggested fill command when touching the green rectangle would be colors other than green.

The suggestion presenting component **226** is configured for presenting determined, filtered, ranked and populated verbal command suggestions in association with a multimodal user interface. Contemplated for presentation are three interface variants: an "exhaustive" interface, an "adaptive" interface and an "embedded" interface. Each of the interface variants facilitates users discovering commands in-situ but make different trade-offs and represent distinct points in the design space of verbal command suggestions to aid command awareness and understanding. The exhaustive interface presents a list of all available operations and example commands for each operation. The adaptive interface presents focused suggestions using contextual overlays that appear when users directly manipulate the active window or parts of the interface. These suggestions appear next to the target of the direct-manipulation input. Finally, the embedded interface presents suggestions next to one or more GUI elements. By varying when, where, and what exemplary commands are presented, the different interfaces encourage different types of discovery and mapping between verbal commands and interface elements.

FIG. **4** is an exemplary screen display **400** illustrating an exhaustive interface. The exhaustive interface is modeled after traditional command menus that show a list of available commands for all operations. In embodiments, users can select an appropriate invocation trigger in the screen display (e.g., a microphone indicator) to be presented with a comprehensive list of available operations and example commands for each operation. A portion of the resultant list is shown in FIG. **4**. To aid readability, the commands may be grouped by operations (as shown) and users may be permitted to collapse/expand operation groups to focus on operations of interest. In embodiments, the exhaustive interface may use some contextual information and deemphasize operations and commands that are not applicable to the active state of the interface. For example, if an image editing application is being utilized and there are no shapes in the active window, the commands for operations corresponding to shapes (e.g., fill color, border size, etc.) may be faded out

(or otherwise deemphasized). The exhaustive interface helps users discover a breadth of commands applicable to an active state of the interface.

FIGS. **5**A-**5**E depict exemplary screen displays illustrating an adaptive interface in accordance with implementations of the present disclosure. In embodiments, the adaptive interface utilizes tooltip-like overlays to suggest verbal commands relating to a target of the direct-manipulation input. FIG. **5**A illustrates presentation of exemplary command suggestions when a user provides a direct-manipulation input on a person in the image of the active window. FIG. **5**B illustrates presentation of exemplary command suggestions when a user provides a direct-manipulation input on a dropdown menu, for instance, in a properties panel of the multimodal interface. FIG. **5**C illustrates presentation of exemplary command suggestions when a user provides a direct-manipulation input on an entity detection button (that is, a selectable button that, when invoked, detects entities in the active window) that is presented, for instance, in a toolbar. FIG. **5**D illustrates presentation of exemplary command suggestions when a user provides a direct-manipulation input on a microphone (talk) trigger. FIG. **5**E illustrates presentation of exemplary command suggestions when a user provides direct-manipulation input on a shape shown in the active window of the multimodal interface.

To invoke command suggestions utilizing the adaptive interface, users can long press (e.g., press-and-hold for greater than one second) on different parts of the interface including the active window, widgets and buttons in the properties panel and toolbar, or the talk button. Suggestions are presented through overlays next to the user's finger. Suggestions may be specific to something directly under the user's finger (e.g., a shape or image object) or may apply more generally to the interface. When utilizing a touch-based interface, to avoid occlusion by the hand, the overlays may appear above the user's finger on the active window and be positioned to the left or right of the properties panel and the toolbar, respectively.

In embodiments, suggestions in the adaptive interface are contextual to the target that is under the user's finger. If the target is a widget, the suggestions are about the widget. If the user is touching the active window, the suggestion will be about the object under the user's finger (e.g., background image, a person, shape, etc. when there is an image in the active window). For instance, suggestions for applying filters (e.g., "apply a grayscale filter") may appear when a user long presses on an add-effect widget invocation button (that is, a selectable button that, when selected, invokes the ability to add effects to a widget) in the properties panel or when a user directly manipulates an object in an image.

The system may suggest any number of exemplary available command suggestions for any number of available operations within the scope of embodiments of the present disclosure. In embodiments, the system may suggest one example command per applicable operation. Command phrasings and parameter values vary over time. For example, the user might first see "Apply a sepia effect here" and later "Add a morph filter." To help users get accustomed to using speech, the system initially suggests simpler phrasings with fewer parameters and incrementally exposes users to more complex phrasings with multiple parameters. This is adaptive in relation to the end-user's "learning." For example, if the user issues single commands enough times, the system switches to multi-parameter commands.

As previously set forth, workflow, as utilized herein, is defined as a set of operations that help a user accomplish a task. For instance, if a user is engaged in a workflow using an image editing application to alter a color image by making it black and white and changing a border color from black to white, a relevant workflow may involve the operations "Apply a grayscale filter" and "Change the border color to white." If the user is following a workflow, the adaptive interface restricts the number of suggestions it presents and prioritizes commands that align with the workflow. For instance, a single verbal command may be suggested to apply the sepia filter if that is the next step in the predefined workflow. However, if no predefined workflow is available, in embodiments, the system defaults to the strategy of suggesting one command per applicable operation.

FIGS. **6**A through **6**D depict exemplary screen displays illustrating an embedded interface in accordance with implementations of the present disclosure. The embedded interface is similar to the adaptive interface with two key differences. First, it creates a visual mapping between GUI elements and their corresponding verbal commands by "augmenting" the GUI widgets with command suggestions. Second it may not consider the user task (i.e., workflow) when choosing relevant examples. The adaptive interface is high precision, low recall and the embedded interface is lower precision, high recall.

In embodiments, the embedded interface presents command suggestions alongside the application GUI. To view command suggestions, users can long press on different parts of the interface. For instance, if the user long presses on the active window, the system may present command suggestions within the properties panel (FIGS. **6**B and **6**C). In exemplary embodiments, emphasized (e.g., colored, bolded, etc.) text may correspond to verbal command suggestions augmenting the GUI widgets in the properties panel. In embodiments, to incrementally discover commands corresponding to the interface panels, users may also directly long press on the toolbar (FIG. **6**A) or the properties panel (rather than pressing only on objects in the active window). Long pressing the talk button displays both exemplary command suggestions corresponding to objects in the active window (FIG. **6**D) and also embeds commands within the toolbar and properties panel.

Because the embedded interface augments the existing GUI widgets, it uses command templates instead of command examples. For instance, the command template "Change border color to _____" may appear next to a dropdown menu for changing the border color. In embodiments, to provide a consistent experience and give users confidence in how to talk, the system displays the same template throughout a session. Because the toolbar leaves little room to embed text commands, in embodiments, suggestions for the tools in the toolbar may take the form of command examples rather than templates similar to the adaptive interface. The examples presented when the user activates a microphone trigger also follow the same approach as the adaptive interface.

In embodiments, instead of or in addition to presentation of exemplary commands in a user interface such that the same may be read by the user, the system may verbally present command suggestions to the user (that is, may "speak" the command through a speaker associated with a user computing device, for instance, the user computing device **210** of FIG. **2**). In exemplary embodiments, a "speak commands" selectable button (not shown) may be selected by the user to prompt the system to provide command suggestions verbally. In embodiments, the default of the system may include verbal presentation. Any and all such

variations, and any combination thereof, are contemplated to be within the scope of embodiments of the present disclosure.

In embodiments, once a verbal command is issued by a user, a combination of a template-based and a lexicon-based parser may be utilized to interpret the received verbal command. Speech parsers are known to those having ordinary skill in the art and, accordingly, are not further described herein. Operations, targets and parameters of the verbal command may be identified by comparing the interpreted verbal input to predefined templates. If the interpreted verbal input does not match a template, the system may tokenize the verbal command string and look for specific keywords to infer the same information. In cases where the verbal command does not contain a target, the system may infer the target through the interface state (e.g., which objects were previously selected) or direct manipulation input (e.g., what object was pointed at when the verbal command was issued). In this way, direct manipulation may be used to specify (or disambiguate) portions of a verbal command.

In embodiments, the system includes a feedback mechanism when a verbal command is not interpreted successfully. In all three interfaces, a feedback region may be presented below the text box and also show exemplary command suggestions generated similarly to the manner described herein above but, instead of in response to a direct-manipulation input, the presented suggestions may be in response to an unrecognized verbal input. To suggest exemplary commands in this region, the system infers a failure type most likely, e.g., based upon heuristics. (Heuristics are known to those having ordinary skill in the art and, accordingly, are not further described herein.) A first type of failure type is phrasing errors. Phrasing errors are errors that are identified as commands that contain a valid parameter but are inconsistent with the grammar or lack keywords (e.g., "Make sepia). In such cases, the system may suggest an example command using that parameter value (e.g., "Add a sepia filter"). A second type of failure type is parameter errors. A parameter error is determined if there is a valid operation but a missing or unsupported parameter value (e.g., "Change fill color" or "Add the retro filter"). In parameter error cases, the feedback indicates that the command is incomplete and presents a list of supported values with an example (e.g., "Change fill color to green"). A third error type, operation-object mapping errors, occur when the system infers both operation and parameters but the command is targeted on an unsupported object (e.g., saying "Apply a morph filter" while pointing on a rectangle). In this case, the feedback may list the applicable object types (i.e., images in this example). Finally, if the system is neither able to infer the operation nor the parameter in a command, the system counts this as a fourth type of failure, an operation recognition error, and indicates to the user that they should try one of the offered verbal command suggestions.

In embodiments, the system includes a feedback mechanism when exclusively direct-manipulation input is employed by a user to achieve a task or action. For instance, if a user employs exclusively direct-manipulation input to, by way of example only, select a color in a dialog box using a mouse, the system may inform the user (e.g., in the feedback region beneath the text box) that: "Instead of using the mouse, you could speak the command "Change the color to red." Such proactive action aids in making the user aware not only that verbal commands may be utilized but also educates the user with regard to exemplary commands and appropriate command phraseology.

Turning now to FIG. **7**, illustrated is a schematic diagram showing an exemplary method **700** for facilitating discoverability of verbal commands in a multimodal interface. As indicated at block **710**, a target associated with a direct-manipulation input received from a user via a multimodal interface associated with a user computing device (e.g., the user computing device **210** of FIG. **2**) is determined (e.g., by the target determining component **218** of the verbal command discovery engine **212** of FIG. **2**). As indicated at block **712**, a set of operations is selected (e.g., utilizing the operations subset selecting component **222** of the verbal command discovery engine **212** of FIG. **2**) on which to focus verbal command suggestions. As indicated at block **714**, one or more verbal command suggestions relevant to the selected set of operations is generated, for instance, by the verbal command suggestion generating component **224** of the verbal command discovery engine **212** of FIG. **2**. Finally, as indicated at block **716**, at least a portion of the generated verbal command suggestions is provided for presentation in association with the multimodal user interface (e.g., utilizing the presenting component **226** of the verbal command discovery engine **212** of FIG. **2**) such that discoverability of verbal commands understood by the system is facilitated.

With reference to FIG. **8**, illustrated is a schematic diagram showing another exemplary method **800** for facilitating discoverability of verbal commands in a multimodal interface. As indicated at block **810**, a target associated with a direct-manipulation input received from a user of a multimodal user interface is determined (e.g., by the target determining component **218** of the verbal command discover engine **212** of FIG. **2**). As indicated at block **812**, a plurality of operations associated with the determined target is determined, for instance, by the operation determining component **220** of the verbal command discovery engine **212** of FIG. **2**. As indicated at block **814**, the operations comprising the plurality of operations are ranked relative to one another to generate a suggestion ranking (e.g., by the operations ranking component **228** of the operations subset selecting component **222** of the verbal command discovery engine **212** of FIG. **2**). As indicated at block **816**, using at least in part the suggestion ranking, a subset of the plurality of operations is selected (e.g., utilizing the operations subset selecting component **222** of the verbal command discovery engine **212** of FIG. **2**). As indicated at block **818**, one or more verbal command suggestions relevant to the subset of operations is generated, for instance, by the verbal command suggestion generating component **224** of the verbal command discovery engine **212** of FIG. **2**. Finally, as indicated at block **820**, at least a portion of the generated verbal command suggestions is provided for presentation in association with the multimodal user interface (e.g., utilizing the presenting component **226** of the verbal command discovery engine **212** of FIG. **2**) such that discoverability of verbal commands understood by the system is facilitated.

Accordingly, embodiments of the present disclosure relate to computing systems for facilitating discovery of verbal commands using multimodal user interfaces. The computer systems may include one or more processors and one or more computer storage media storing computer-usable instructions that, when used by the one or more processors, cause the one or more processors to perform several functions. In embodiments, such functions may include determining a target associated with a direct-manipulation input received from a user via a multimodal user interface; selecting a set of operations relevant to the determined target; generating one or more verbal command suggestions relevant to the selected set of operations and to the determined

target; and providing at least a portion of the generated one or more verbal command suggestions for presentation in association with the multimodal user interface such that discoverability of verbal commands understood by the system is facilitated.

Embodiments of the present disclosure further relate to computer-implemented methods for facilitating discovery of verbal commands using multimodal interfaces. Such computer-implemented methods may include determining a target associated with a direct-manipulation input from a user of a multimodal user interface; determining a plurality of operations associated with the determined target; ranking operations comprising the plurality of operations relative to one another to generate a suggestion ranking; using, at least in part, the suggestion ranking, selecting a subset of the plurality of operations relevant to the determined target; generating one or more verbal command suggestions relevant to the selected subset of operations and to the determined target; and providing at least a portion of the generated one or more verbal command suggestions for presentation in association with the multimodal user interface such that discoverability of verbal commands by the user is facilitated.

Some embodiments of the present disclosure relate to computing systems for facilitating discovery of verbal commands using multimodal interfaces. Such computing systems may comprise means for generating one or more verbal command suggestions relevant to a target of a direct-manipulation input received from a user via multimodal user interface; and means for providing at least the portion of the one or more verbal command suggestions for presentation in association with the multimodal user interface such that discoverability of verbal commands understood by the system is facilitated.

Having described implementations of the present disclosure, an exemplary operating environment in which embodiments of the present disclosure may be implemented is described below in order to provide a general context for various aspects hereof. Referring to FIG. **9**, an exemplary operating environment for implementing embodiments of the present disclosure is shown and designated generally as computing device **900**. The computing device **900** is but one example of a suitable computing environment and is not intended to suggest any limitation as to the scope of use or functionality of the invention. Neither should the computing device **900** be interpreted as having any dependency or requirement relating to any one or combination of components illustrated.

Embodiments hereof may be described in the general context of computer code or machine-usable instructions, including computer-executable instructions such as program modules, being executed by a computer or other machine, such as a personal data assistant or other handheld device. Generally, program modules including routines, programs, objects, components, data structures, etc., refer to code that perform particular tasks or implement particular abstract data types. Embodiments of the present disclosure may be practiced in a variety of system configurations, including hand-held devices, consumer electronics, general-purpose computers, more specialty computing devices, etc. Embodiments of the present disclosure also may be practiced in distributed computing environments where tasks are performed by remote-processing devices that are linked through a communications network.

With continued reference to FIG. **9**, the computing device **900** includes a bus **910** that directly or indirectly couples the following devices: a memory **912**, one or more processors **914**, one or more presentation components **916**, input/output (I/O) ports **918**, input/output components **920**, and an illustrative power supply **922**. The bus **910** represents what may be one or more buses (such as an address bus, data bus, or combination thereof). Although the various blocks of FIG. **9** are shown with lines for the sake of clarity, in reality, delineating various components is not so clear, and metaphorically, the lines would more accurately be grey and fuzzy. For example, one may consider a presentation component such as a display device to be an I/O component. Also, processors have memory. The inventors recognize that such is the nature of the art, and reiterate that the diagram of FIG. **9** is merely illustrative of an exemplary computing device that can be used in connection with one or more embodiments of the present invention. Distinction is not made between such categories as "workstation," "server," "laptop," "hand-held device," etc., as all are contemplated within the scope of FIG. **9** and reference to "computing device."

The computing device **900** typically includes a variety of computer-readable media. Computer-readable media can be any available media that can be accessed by the computing device **900** and includes both volatile and nonvolatile media, removable and non-removable media. By way of example, and not limitation, computer-readable media may comprise computer storage media and communication media. Computer storage media includes both volatile and nonvolatile, removable and non-removable media implemented in any method or technology for storage of information such as computer-readable instructions, data structures, program modules or other data. Computer storage media includes, but is not limited to, RAM, ROM, EEPROM, flash memory or other memory technology, CD-ROM, digital versatile disks (DVD) or other optical disk storage, magnetic cassettes, magnetic tape, magnetic disk storage or other magnetic storage devices, or any other medium which can be used to store the desired information and which can be accessed by the computing device **900**. Computer storage media does not comprise signals per se. Communication media typically embodies computer-readable instructions, data structures, program modules or other data in a modulated data signal such as a carrier wave or other transport mechanism and includes any information delivery media. The term "modulated data signal" means a signal that has one or more of its characteristics set or changed in such a manner as to encode information in the signal. By way of example, and not limitation, communication media includes wired media such as a wired network or direct-wired connection, and wireless media such as acoustic, RF, infrared and other wireless media. Combinations of any of the above should also be included within the scope of computer-readable media.

The memory **912** includes computer storage media in the form of volatile and/or nonvolatile memory. The memory may be removable, non-removable, or a combination thereof. Exemplary hardware devices include solid-state memory, hard drives, optical-disc drives, etc. The computing device **900** includes one or more processors that read data from various entities such as the memory **912** or the I/O components **920**. The presentation component(s) **916** present data indications to a user or other device. Exemplary presentation components include a display device, speaker, printing component, vibrating component, etc.

The I/O ports **918** allow the computing device **900** to be logically coupled to other devices including the I/O components **920**, some of which may be built in. Illustrative components include a microphone, joystick, game pad, satellite dish, scanner, printer, wireless device, etc. The I/O

components **920** may provide a natural user interface (NUI) that processes air gestures, voice, or other physiological inputs generated by a user. In some instance, inputs may be transmitted to an appropriate network element for further processing. A NUI may implement any combination of speech recognition, touch and stylus recognition, facial recognition, biometric recognition, gesture recognition both on screen and adjacent to the screen, air gestures, head and eye-tracking, and touch recognition associated with displays on the computing device **900**. The computing device **600** may be equipped with depth cameras, such as, stereoscopic camera systems, infrared camera systems, RGB camera systems, and combinations of these for gesture detection and recognition. Additionally, the computing device **900** may be equipped with accelerometers or gyroscopes that enable detection of motion.

As described above, implementations of the present disclosure relate to a framework for generating and presenting examples of verbal commands (e.g., natural language commands) to facilitate discoverability of relevant verbal commands understood by systems supporting multimodal interfaces and to permit users to incrementally explore available verbal commands. The present disclosure has been described in relation to particular embodiments, which are intended in all respects to be illustrative rather than restrictive. Alternative embodiments will become apparent to those of ordinary skill in the art to which the present invention pertains without departing from its scope.

From the foregoing, it will be seen that this disclosure is one well adapted to attain all the ends and objects set forth above, together with other advantages which are obvious and inherent to the system and method. It will be understood that certain features and sub-combinations are of utility and may be employed without reference to other features and sub-combinations. This is contemplated by and is within the scope of the claims.

What is claimed is:

1. A computing system comprising:

one or more processors; and

one or more computer storage media storing computer-useable instructions that, when used by the one or more processors, cause the one or more processors to:

determine a target associated with a direct-manipulation input received from a user via a multimodal user interface;

select a set of operations relevant to the determined target;

generate one or more verbal command suggestions relevant to the selected set of operations and to the determined target by:

selecting a set of phrasing templates relevant to the set of operations based upon at least one of a type of the direct-manipulation input received, and a complexity of each phrasing template included in the set of phrasing templates, wherein the complexity is based on a quantity of modifiable parameters in each of the phrasing templates included in the set of phrasing templates; and

generating the one or more verbal command suggestions utilizing the set of phrasing templates; and

provide at least a portion of the generated one or more verbal command suggestions for presentation in association with the multimodal user interface such that discoverability of verbal commands understood by the system is facilitated.

2. The computing system of claim **1**, wherein the computer-useable instructions, when used by the one or more processors, cause the one or more processors to select the set of operations relevant to the determined target by:

determining a plurality of operations associated with the determined target;

ranking operations comprising the plurality of operations relative to one another to generate a suggestion ranking; and

using, at least in part, the suggestion ranking, selecting the set of operations relevant to the determined target.

3. The computing system of claim **2**, wherein the computer-useable instructions, when used by the one or more processors, cause the one or more processors to rank the operations comprising the plurality of operations relative to one another based upon at least one of a type associated with the determined target, relevance to a workflow engaged in by the user, an operation issued-count and an operation shown-count to generate the suggestion ranking.

4. The computing system of claim **1**, wherein the computer-useable instructions, when used by the one or more processors, further cause the one or more processors to populate at least one modifiable parameter of the phrasing templates included in the set of phrasing templates with a parameter value to generate one of the one or more verbal command suggestions.

5. The computing system of claim **4**, wherein the computer-useable instructions, when used by the one or more processors, cause the one or more processors to populate the modifiable parameter with the parameter value based on at least one of an active state of the target and relevance to a workflow engaged in by the user.

6. The computing system of claim **1**, wherein the received direct-manipulation input is one of a touch input, a keyboard input, an eye-tracking input, a gesture input, or a mouse input.

7. The computing system of claim **1**, wherein at least one of the one or more verbal command suggestions is a natural language command suggestion.

8. The computing system of claim **1**, wherein selecting a set of phrasing templates comprises selecting a first set of phrasing templates based on a first type of the direct-manipulation, and selecting a second set of phrasing templates based on a second type of the direct-manipulation, wherein the first type and the second type of the direct-manipulation are different.

9. A computer-implemented method, comprising:

determining a target associated with a direct-manipulation input received from a user of a multimodal user interface;

determining a plurality of operations associated with the determined target;

ranking operations of the plurality of operations relative to one another based upon a type associated with the determined target and relevance to a workflow engaged in by the user to generate a suggestion ranking, wherein the workflow is a set of predefined operations associated with a task, and wherein the relevance to the workflow is based on a previous operation of the workflow engaged in by the user;

using the suggestion ranking, selecting a subset of the plurality of operations relevant to the determined target;

generating one or more verbal command suggestions relevant to the subset of operations and to the determined target; and

providing at least a portion of the generated one or more verbal command suggestions for presentation in asso-

ciation with the multimodal user interface such that discoverability of verbal commands by the user is facilitated.

10. The computer-implemented method of claim **9**, wherein the one or more verbal command suggestions that are relevant to the subset of operations and to the determined target is generated by:

selecting a set of phrasing templates relevant to the subset of operations;

generating the one or more verbal command suggestions utilizing the set of phrasing templates.

11. The computer-implemented method of claim **10**, wherein the set of phrasing templates relevant to the subset of operations is selected based upon at least one of a type of the direct-manipulation input received, a complexity of each phrasing template included in the set of phrasing templates, a template issued-count and a template shown-count.

12. The computer-implemented method of claim **10**, wherein at least one phrasing template of the set of phrasing templates includes a modifiable parameter, and wherein the method further comprises populating the modifiable parameter with a parameter value to generate one of the one or more verbal command suggestions.

13. The computer-implemented method of claim **12**, wherein the modifiable parameter is populated with a parameter value based on at least one of an active state of the target and relevance to a workflow engaged in by the user.

14. The computer-implemented method of claim **9**, wherein the received direct-manipulation input is one of a touch input, a keyboard input, an eye-tracking input, a gesture input, or a mouse input.

15. The computer-implemented method of claim **9**, wherein at least one of the one or more verbal command suggestions is a natural language command suggestion.

16. A computing system comprising:

means for selecting a set of phrasing templates relevant to a set of operations based on a quantity of modifiable parameters in phrasing templates of the set of phrasing templates;

means for generating, utilizing the set of phrasing templates, one or more verbal command suggestions relevant to a target of a direct-manipulation input and a type of the direct-manipulation input received from a user via a multimodal user interface, wherein the received direct-manipulation input is one of a keyboard input, or a mouse input; and

means for providing at least a portion of the one or more verbal command suggestions for presentation in association with the multimodal user interface such that discoverability of verbal commands understood by the system is facilitated.

17. The computing system of claim **16**, further comprising means for a selecting a set of operations that are relevant to the target of the direct-manipulation input, wherein the means for generating the one or more verbal command suggestions comprises means for generating the one or more verbal command suggestions that are relevant to the set of operations and to the target of the direct-manipulation input.

18. The computing system of claim **17**, further comprising means for selecting a set of phrasing templates relevant to the set of operations; wherein the means for generating the one or more verbal command suggestions comprises means for generating the one or more verbal command suggestions utilizing the set of phrasing templates.

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